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JACQUES LOEB AND HIS PERIOD[1]

JACQUES LOEB was born in Germany in 1859, within a few miles of Strasbourg, or in a region in which French and German culture had long mingled. His forebears were among the intellectuals who during the persecutions attendant on the Inquisition were driven out of Portugal and compelled to seek asylum in a more liberal country. They migrated from Lisbon to Amsterdam, and in later and quieter times settled in Alsace. Thus, along with an inheritance distinctly intellectual, Loeb profited by contact with one of the richest European cultures during his formative period. The intellectual cosmopolitanism which moulded his growth into physical maturity served him well throughout his varied life. He was easily at home in the sophisticated intellectual atmosphere of Europe and in the younger but rapidly developing intellectual atmosphere of the United States, where he passed the years from 1891 to 1924.

The influence of the French environment on Loeb's mental growth is shown by the part the writings of Voltaire and the French encyclopedists played in it; and the influence of German surroundings is shown equally by the German *Gymnasium* and university training. Loeb attended three German universities—Berlin, Strassburg and Würzburg. It was at Strassburg and Würzburg that he met the conditions which were to guide his subsequent scientific undertakings. But his emotions were profoundly stirred and his inclination toward humanitarianism was fed by the French philosophers, and he always looked to these writers as among the great intellectual and spiritual liberators of all time. In his book, "The Organism as a Whole," published during the great war, his tormented mind returns to them in the search for an anchor and haven of hope. "This book is dedicated to that group of free thinkers, . . ., who first dared to follow the consequences of a mechanistic science, . . ., to the rules of human conduct and thereby laid the foundations of that spirit of tolerance, justice, and gentleness which was the hope of our civilization . . .," until swept away by the great war.

But it was the advanced system of scientific training

[1] Based on an address made at the exercises held at the Marine Biological Laboratory, Woods Hole, Massachusetts, on August 4, 1927, in connection with the erection of a tablet to Jacques Loeb.

of the German university which emancipated Loeb intellectually by providing him with a foundation for his experimental studies. Loeb entered upon his university career at a propitious time; the German laboratories were filled with eager investigators and their thought was dominated by many fundamental problems in physics, chemistry and biology. For a person like Loeb this fortunate circumstance could not fail to yield a significant result. His natively strong, perspicacious, inquiring mind, already colored by the writings of the French philosophers and naturally tending away from superstition and metaphysical conceptions, readily found a resting place in the growing physico-chemical beliefs of the time.

Loeb received the M.D. degree at Strassburg in 1884. To one looking backward in a desire to follow the story of his intellectual development it would seem natural that he should soon discover that it was not medicine as an art so much as medicine as a science to which his tastes turned. Medicine has in the past served as the doorway leading into science for not a few conspicuous men: through it passed Galileo, Gilbert, Young, Helmholtz, and in our day and country Ira Remsen. Even during Loeb's novitiate, as it were, less than to-day was medicine to be counted among the objective experimental sciences. But if experimental medicine, as such, was still woefully backward, physiology, that basic science of biology and medicine, had already made significant progress. During Loeb's student days, Claude Bernard had just ceased his colossal labors and Johannes Müller had hardly more than completed his extraordinary career as leader and modernist in physiology, pathology and clinical medicine, and had left to extend his influence the brilliant pupils Helmholtz and du Bois-Reymond. Moreover Ludwig was already started on the remarkable undertaking to develop quantitative physical physiology which was to produce a generation of investigators and teachers in that field.

It was very good fortune which directed Loeb to Strassburg and a fortune doubtless connected with his Alsatian birth. Into that French-German environment, the German government projected after 1870 a center of higher learning staffed by a group of brilliant investigators and teachers. To the medical faculty it sent such men as Hoppe-Seyler, von Recklinghausen, Schmiedeberg, Naunyn and Goltz. These are names to conjure with in biological chemistry, pathology, pharmacology, medicine and physiology. Loeb was attracted to Goltz, the pupil of Helmholtz, who was adding conspicuously to the then beginning knowledge of cardiac pressure, the mechanism of shock, functions of the semicircular canals, and the effects of excision of the brain and spinal cord in the frog and dog. That the last-mentioned subject should be the one to claim Loeb's special interest is not perhaps remarkable in view of his philosophic prepossessions. It was at this time that Loeb experimented on the chain reflexes and overthrew Munk's thesis that the Rolandic area is composed of cellular "sensory spheres," by showing that the particular paralyses occasioned by each cortical excision are abolished as soon as the wound has healed. The interest in the centers of brain activity thus aroused was to be continued in his later investigation of tropisms with which he concerned himself at Naples, and which led him to substitute for the anthropomorphic conception of the responses of animals according to supposed desires directing voluntary effort, the operation of tropisms or physico-chemical attraction, on the basis of which there was to arise a mechanistic conception of comparative psychology.

At this point it is desirable to retrace a few steps in order to follow the particular events which were to influence so greatly Loeb's scientific development. Like other discoverers in science, Loeb was the product of his period. This central fact in his notable career will become increasingly evident as we proceed. At the threshold of his life's work circumstances brought Loeb from Strassburg to Würzburg, to be the assistant of Fick, a pupil of Ludwig, then professor of physiology, whose contributions to knowledge in the domain of physical physiology are significant. The investigation of such problems as the physiology of the irritable substances, dissipation of energy and heat production in muscle, as well as the publication of larger works on medical physics, would appear to be sufficient to have attracted the quantitatively minded student of physiology to this particular master.

But whatever the benefit derived from this connection, it was small compared with the rewards in store from the chance association with Sachs which it brought about. The association produced admiration and led to friendship as well as to an impulse of direction in scientific pursuit which was to remain essentially fixed throughout Loeb's exceptionally rich and varied career. It was the fortunate chance encounter with Sachs which turned Loeb's talents into the broad channel of general physiology. Has not Claude Bernard[2] said that general physiology is the basic biological science toward which all others converge? Loeb was to find the truth of this axiom for himself and through his discoveries reveal it to a generation of investigators in a far distant land.

The botanist Sachs's personality and discoveries may be said to have dominated the field of plant

2 Bernard, Claude, "An Introduction to the Study of Experimental Medicine," The Macmillan Co., 1927, p. 65.

physiology for more than thirty years, between 1857 and 1890, and his influence continues up to the present time. The physiology developed by Sachs was based on chemical and physical actions which he described under the term tropisms: heliotropism, chemotropism, geotropism—or reactions to light, chemicals and gravity. Loeb's alert mind grasped the significance of these phenomena, not only for plants but probably also for animals, so that we find him spending the winter months from 1889 to 1891 at the Naples Zoological Station, where the ideas he had formed could be subjected to experimental test. It was this period and under these particular circumstances that yielded Loeb's discoveries in the animal tropisms and in heteromorphosis.

In a recent biographical sketch,[3] one of his distinguished pupils ascribes the studies leading to the idea of heteromorphosis to a desire on Loeb's part to combat the vitalistic conception of orderly animal development. This purpose may well have had a part in the planning of the experiments, since at a later date Loeb became a warm antagonist of all mystical biological beliefs. Be this at it may, Loeb would seem to have been moved also by the conviction that the physico-chemical forces acting on living matter are one and the same, both for plants and animals. In other words, he applied by means of sharp, ingenious experiments the discoveries made by Sachs in plants to animals as well. Later Loeb extended the observations into the field of psychology and found them to hold there, so that he came to apply his deductions to the explanation of certain phenomena of animal behavior. This line of investigation would have been approved by Claude Bernard who wrote: "I am persuaded that the obstacles surrounding the experimental study of psychological phenomena are largely due to difficulties (associated properties) of this kind; for despite their marvelous character and the delicacy of their manifestations, I find it impossible not to include cerebral phenomena, like all other phenomena of living bodies, in the laws of scientific determinism.[4]

Just as scientific men are made by their time, so extraordinary scientific men make their time what it is. Loeb is now definitely launched on his life's work which was, as far as was possible to him and with the knowledge available, to reduce biological appearances, the so-called manifestations of life, to the status of physico-chemical reactions. It is in connection with the investigation of the physico-chemical relations of vital phenomena that Loeb has exercised so great an influence on his generation. This is, of course, not the occasion on which to enter into a discussion of the controversy, not yet wholly adjusted, on vitalism *versus* determinism. Early in Loeb's scientific career, far more so than at present, the nature of vital phenomena was a subject of eager debate. In this early period, the emancipation from mystical notions had not yet come to some great minds. Was not Johannes Müller, the German colossus who bestrode all there was of medical science in his day and who was the master of Helmholtz, a confessed vitalist? He believed in the existence of something in vital processes which does not admit of mechanical expression; his strongly objective mind forced him, none the less, to hold that the mechanical explanation of physiological phenomena was to be pushed to the limit "so long as we keep to the solid ground of observation and experiment."

Fortunately, natural science had progressed further in France in the first half of the nineteenth century than in Germany. The influence of the discoveries of chemists such as Dumas and Berthelot and of others penetrated into physiology. The times brought forward the extraordinary figure of Claude Bernard, of whom Dumas said: "He was no mere physiological experimenter, but physiology itself." Like Magendie and Johannes Müller, he made his bow to vitalism, but gave it the widest possible berth.[5] Paul Bert, pupil and successor to his chair at the Sorbonne, said that, thanks to Claude Bernard, "the scientific method, respect for whose laws leads to certainty in the sciences of dead matter, assumed equal authority in the sciences of living beings." The stage was set for the new era in biology which was now to be established on the rapidly expanding sciences of physics and chemistry.

A succession of remarkable men appeared and their accomplishments were destined to transform the outlook on the natural sciences. Thus, Loeb's generation of biologists was called upon to sustain a weight of investigative genius in physics and chemistry of hitherto unknown magnitude; and to his lasting credit Loeb was to perceive the trend of events and to sense the extraordinary influence which these sciences were to exert on physiology. Hence he threw his splendid talents into the study of biological phenomena along the lines of their physical and chemical activities, with results of which you are aware and which proved to be of the first importance for the subject of general physiology as now conceived. How great this weight of investigative influence was can

[3] Robertson, T. B., *Science Progress*, July, 1926–27, xxi, p. 114.

[4] Bernard, Claude, "An Introduction to the Study of Experimental Medicine," The Macmillan Co., 1927, p. 91.

[5] Garrison, F. H., "Introduction to the History of Medicine," Edition II, Philadelphia, 1917, p. 576.

best be seen from a tabulation, somewhat arbitrarily constructed, which I present. The remarkable effect which the development of that composite science we call physical chemistry—a union of mathematics, physics and chemistry—was to exercise on biology and in the application of which to the interpretation of phenomena of living matter Loeb was an outstanding figure, is presaged in the fundamental discoveries of Gibbs, Pfeffer, van't Hoff, Ostwald, Arrhenius and J. J. Thomson, with whose period Loeb's is in immediate contact.

Faraday	1791–1867
Liebig	1803–1873
Wöhler	1800–1882
J. Müller	1801–1858
Bernard	1813–1878
Ludwig	1816–1895
du Bois-Reymond	1818–1896
Helmholtz	1821–1894
Virchow	1821–1902
Pasteur	1822–1895
Fick	1829–1901
Maxwell	1831–1879
Sachs	1832–1897
Goltz	1834–1902
Gibbs	1839–1903
Pfeffer	1845–1920
Emil Fischer	1852–1919
van't Hoff	1852–1911
Ostwald	1853–
Ehrlich	1854–1915
J. J. Thomson	1856–
Arrhenius	1859–
Loeb	1859–1924
Nernst	1864–
Donnon	1870–
Einstein	1879–

It was characteristic of Loeb's agile mind that he should so surely and quickly catch the drift of thought and feeling, or the *Zeitgeist,* of the period and proceed to bend the new physico-chemical knowledge to the uses of physiology. This was only repeating what he had already done with Sach's tropisms, and is something which fertile minds are always doing or striving to do. A mathematician has told me that the growth of mathematics in the last fifty years made possible Einstein's calculations, which corrected and extended Newton's discoveries. Taken all in all, physical chemistry constituted for Loeb the bright silver thread on which are strung the brilliant beads of his discoveries. What the chief of these beads are may be read on the bronze tablet erected to-day to his imperishable memory: "Brain Physiology; Tropisms; Regeneration; Antagonistic Salt Action; Duration of Life; Colloidal Behavior." A remarkable list truly of significant titles, and more remarkable even in that these complex phenomena should have been brought so largely within the definition of physico-chemical action.

* * * * *

Jacques Loeb has been among us so recently that many of us recall as of yesterday his vivid personality—his scholarly, slightly stooped figure, his noble head with strongly marked, reflective features, his thoughtful and somewhat pensive eyes, and the hearty, merry peal of laughter with which he lightened passing events of a world to him not always devoid of depressing moments and anxious thoughts.

The man Loeb was the scientist, ever pursued by an inner demon demanding of him the solution of the next problem. It is of men like Loeb that Priestley said that each discovery shows many other discoveries that should be made, and Pascal invented the paradox that, "We are in search never of things, but of the search for things." Loeb gave himself no respite; each succeeding year he drove, if possible, with greater intensity toward a goal always being approached and yet always eluding. Possessed of that vigorous quality of imagination which goes by the name of intuition or even inspiration, and which in essence consists of a feeling in the mind that amounts to a presentiment of truth, he was a remarkably fruitful inventor of ideas or hypotheses, the experimental verification of which is the chief means of extending scientific knowledge. His prescience reminds an associate of Faraday, because of Loeb's uncanny gift of knowing the truth before the experiment was made. "I know what it is; the question is how to prove it."[6] The proof might be long in coming, but it would come and then the result would be startling. Loeb's habit was to ponder, sometimes for years, chance findings, until the mode of attack of the problem appeared, and he then moved with precision and celerity. In this way fragmentary observations, partly his own and partly others, on artificial fertilization led to the discovery of its production at will, and artificial parthenogenesis was discovered.

Newton said that he made his discoveries "by always thinking unto them . . . till the first dawnings open slowly little by little into a full clear light." The power of long thought is something that goes with the highly original gift which we associate with genius. Buffon said that genius is patience, and Newton attributed his discoveries to "nothing but industry and patient thought." Claude Bernard's definition is more searching: "Genius is revealed in a

[6] Northrop, J. H., "Jacques Loeb—1859 to 1924," *Ind. Eng. Chem.*, 1924, xvi, 318.

delicate feeling which correctly foresees the laws of natural phenomena; but this we must never forget, that correctness of feeling and fertility of idea can be established and proved only by experiment."[7] "Genius is patience? No, it is not quite that, or rather it is much more than that; but genius without patience is like fire without fuel—it will soon burn itself out."[8] Loeb possessed the patience and he had the industry; alas, his industry was in excess of his physical constitution, so that he burned out his life before he consumed his talents.

In 1910 Loeb exchanged a professorship at the University of California for membership in The Rockefeller Institute for Medical Research. He organized at the Rockefeller Institute the Division of General Physiology, the first department of the kind to be created in the United States. It was fitting that Loeb, whose discoveries had so enriched general biological science, should have been the pioneer of general physiology in this country. The growth of the new establishment was such that in 1918 a *Journal of General Physiology* was called for and Loeb undertook the task of founding and editing such a journal. His removal to New York called for modification of the research program. As may be observed from his discoveries in the field of colloid chemistry, his fertile mind met the new conditions. By dividing the year between New York and Woods Hole, Loeb's working facilities were enlarged; and this happy arrangement filled his last years with scientific opportunity commensurate with his needs, sympathetic scientific association, and although grudgingly given with those recreative enjoyments which his intense nature required.

Loeb was of the type of the intensive individual investigator; hence his immediate pupils are not numerous. But if Loeb's direct influence was reserved for a favored few, his wider influence has been shared by a large body of students and investigators and even by the educated lay public. His personal contact with successive groups of scientific workers at Woods Hole, the Rockefeller Institute, and elsewhere has been of incalculable value. Loeb's profound scientific learning and experience, wide reading, liberal views often warmly expressed, vivid imagination widely dispensed, and his fund of sparkling wit made him at all times a stirring and delightful companion. No one could have been kinder than Loeb in his human relations; and fortunate were those who came under the reign of his genial, many-sided personality. It is unhappily too true of him "that he may be succeeded, but can not be replaced."

[7] Bernard, Claude, "An Introduction to the Study of Experimental Medicine," The Macmillan Co., 1927, p. 43.

[8] Lodge, Sir Oliver, "Pioneers of Science," London, The Macmillan Co., 1893, p. 202.

Jacques Loeb's life was spent in an ardent desire to interpret nature. It was peculiarly true of him, as has been said, that knowledge is at once the sole torment and the sole happiness. He knew as few come to know the joy of discovery, which is one of the liveliest the mind of man can feel. He knew also, almost too well, that this joy of discovery, to which his inner demon impelled him, is no sooner found than lost; that it is but a flash, whose gleam discovers fresh horizons, toward which our insatiate curiosity repairs with still more ardor. This is research: the search for truth which, if never found in its wholeness, is yet secured in significant fragments; and these fragments of universal truth are precisely what constitutes science.[9] To this search for fragments of universal truth in living matter Jacques Loeb devoted his great talents and his rich life.

SIMON FLEXNER

THE ROCKEFELLER INSTITUTE FOR MEDICAL RESEARCH, NEW YORK

CHEMISTRY IN RELATION TO BIOLOGY AND MEDICINE WITH ESPECIAL REFERENCE TO INSULIN AND OTHER HORMONES

II

ORGANS OF INTERNAL SECRETION

I may now be permitted to call your attention to a field of knowledge that has occupied experimenters for more than half a century—a field of great importance not only to the biologist in general, but to those who are associated in any way with medicine, as the bio-chemist, the physiologist, pharmacologist, the numerous representatives of the medical and surgical professions—a field that is concerned with a study of the functions, both normal and abnormal, of the organs of internal secretion. To the chemist is given a unique opportunity in this field and here, as is so often the case in biology, the last word is his. In saying this I have particularly in mind the obvious chemical aspects of the problems here presented, as, once they are cleared up, the physiologist and the physician are enabled to outline their own problems relating to the function of these organs with greater precision.

The significance of the interdependence of the various mechanisms of the animal body, of their admirably regulated activity and the harmonious manner in which these mechanisms cooperate in the development and growth of the individual from the moment when they first become apparent in early embryonic life to

[9] Bernard, Claude, "An Introduction to the Study of Experimental Medicine," The Macmillan Co., 1927, p. 222.

the time when we are returned to the dust from which we sprang has no doubt always been apparent to the mind of man, as is so well illustrated in Aesop's fable that it will not do for the various members of the body to fall out with each other. The medicine of an older time has long used the words *consensus partium,* the mutual dependence on each other, in other words, this interrelationship, of the various organs. Generally speaking, until about a century ago the *consensus partium* was supposed to be effected solely through the intermediation of the nervous system—a point of view tersely expressed in 1752 by the French anatomist Cuvier when he said: "Le système nerveux est, au fond, tout l'animal, les autres systèmes ne sont là que pour le servir." According to this view, then, to put the matter in popular language, certain control stations in the brain and spinal cord and of the peripheral autonomic nervous system coordinate all the functional activities solely by means of telegraphic communication (though a nervous impulse is quite a different thing from an electric current). During the past seventy years, however, conjoined chemical and physiological discoveries have brought to light a new method of communication between organs and a coordination of their functional activities, closely linked, to be sure, with the longer known type of control but yet quite distinctly different. To-day we also have, as Professor Starling so aptly put it, an efficient postal service at the disposal of the various mechanisms of our body. The little packets of chemicals sent out by the organs of internal secretion are carried by the blood stream to their appointed destinations and are generally called hormones, the name given to them by Starling twenty years ago. The term is derived from the Greek verb ὁρμαω (I stir up or excite), and is perhaps less appropriate than the designation *chemical messenger,* earlier applied to this class of substances by the same physiologist.

These chemical messengers may initiate changes in the functional state of a distant nerve cell or nerve terminal, or a series of chemical changes, or take part in some intermediary chemical reactions in a distant organ—reactions that may or may not have been initiated primarily by a preliminary nervous impulse or telegraphic message.

The organs in which these chemical messengers are elaborated and from which they are despatched into the blood stream are known as organs of internal secretion, or endocrine organs. Some of these are called ductless glands—structures that are entirely devoid of secretory ducts, as their name implies, and can only perform their functions by sending their chemical messengers into the blood and lymph, by which they are transmitted to the various organs of the body. Examples of such ductless glands are the thyroid, the parathyroids, the pituitary organ and the intestinal mucosa. Examples of endocrine organs that play the double rôle of producing ferments or other chemical agents that are eliminated by special ducts or passages as well as chemical messengers that pass into the blood stream are the pancreas and the sex glands.

The entire list of organs possessing an endocrine function need not be given here. Let it suffice to say that additions to the list of chemical messengers are constantly being made as the conceptions in this department of physiology have broadened in consequence of more intensive experimentation. Organs such as the heart, for example, have been shown to produce substances that influence the rate of its contractions by an action on its regulatory nervous mechanism. The carbon dioxide that is excreted by our tissues as an end product of their metabolic activity acts as a hormone or regulator of the external respiratory apparatus. In the widest and perhaps truest sense of the word, every tissue, as Schäfer remarks, is an internally secreting structure.

Juice expressed from the embryonic heart of the chick contains a chemical substance, or perhaps more than one, that is indispensable for the continued growth, in the warm chamber, of an isolated fragment of an embryonic heart. This continued maintenance of life and growth in the thermostat of fragments of tissues excised from cold or warm blooded animals or from tumors was initiated by Ross G. Harrison and is known as tissue culture. Carrel has suggested the term "Trephones" (from γρέφω—I feed) for the growth-promoting substances of embryonic tissue juice and of leucocytic extracts. I have called to your mind the work of Carrel and his associates on the artificial propagation of the fibroblasts taken from a fragment of the embryonic heart of the chick because the indispensable trephones or growth-producing substances that must constantly be added to the culture medium may properly be called hormones. They are produced in the cell laboratories of the chick's heart and function in some as yet unexplained manner as regulators of the complex intermediate chemical processes that are necessary to the orderly life of the cell. It will interest you in this connection to learn that Carrel and his collaborators have, from January, 1912, to June, 1927, carried a fragment of embryonic heart tissue through 2,987 generations or "passages of cultivation." There is no reason to doubt that this fragment of tissue would continue to develop indefinitely, provided only the temperature of the thermostat be maintained at 37.5° and that the composition of the nutritive medium remains constant. These extraordinary growth-promoting substances or cata-

lysts of the embryonic tissue (and of leucocytes) may for the present be classed with the hormones.

You are all aware that modern research has revealed the astonishing fact that we require for the complete nourishment of the body, in addition to the energy-yielding and mineral constituents of our food, minute quantities of other substances which are called vitamins. There are many analogies between the physiological properties of these vitamins, which may be called hormones of plant origin, and those that are produced in the animal organism.

According to many plant physiologists, chemical messengers appear to play an important, if not occasionally a greater, rôle in the life of plants than they do in that of animals, but as this phase of the subject lies outside the field of my own experimentation I shall content myself with having called it to your attention.

I can not enter into the details of the story of the discovery of the functions of the ductless glands proper or of the endocrine functions of the organs that have both an external and an internal secretion. The whole subject constitutes one of the greatest contributions of the nineteenth century to scientific medicine. Osler in his "Evolution of Modern Medicine" gives it as his opinion that

> there is perhaps no more fascinating story in the history of science than that of the discovery of the so-called ductless glands. . . . No such miracles have ever been wrought by physicians as those which we see in connection with the internal secretion of the thyroid gland. The myth of bringing the dead back to life has been associated with the names of many great healers since the incident of Empedocles and Pantheia, but nowadays the dead in mind and the deformed in body may be restored by the touch of the magic wand of science. The study of the interaction of these internal secretions, their influence upon development, upon mental processes and upon disorders of metabolism is likely to prove in the future of a benefit scarcely less remarkable than that which we have traced in the infectious diseases.

We are but at the beginnings of knowledge, especially as concerns the chemical and physiological problems that are presented in this great field. Consider, for example, that remarkable and still unknown hormone elaborated in the anterior lobe of the hypophysis and passing from thence into the blood. In it we have a chemical agent that can affect the growth of bone and other structures to an extraordinary degree. The unchecked action of this growth-stimulating principle, extending over a period of years, leads to acromegaly or gigantism. Evans and Long, by injecting potent extracts of the anterior lobe of the hypophysis daily into young rats, have succeeded in producing veritable giants of their species. One typical experiment may be cited: a rat received intraperitoneally anterior hypophyseal substance for a period of 333 days. At the end of that time the animal weighed 596 grams, while its healthy litter mate control weighed only 248 grams.

Studies of this nature have succeeded for the first time in throwing a bridge across the chasm that has hitherto separated bio-chemistry from morphology. Distinguished anatomists, indeed, as Sir Arthur Keith and Professor Bulk, of Amsterdam, have expressed their conviction that the differentiation of mankind into racial types is due to the differential interaction of these endocrine organs. The cumulative experience of a host of medical observers during the past seventy-five years has demonstrated beyond a doubt that innumerable departures from the normal in respect to bodily stature, facial configuration, sexuality, general metabolism and even the mentality find their explanation in the over- or under-activity of these, anatomically speaking often quite insignificant, structures, or in a lack of harmony in their cooperation. It is one of the tragedies of life, a decree of fate, that we should be both "the beneficiaries and the victims of the chemical activities and correlations of our endocrine organs."

Our chemical knowledge of the elusive principles, elaborated in minute quantities only by these indispensable organs, is in its infancy, as I have already intimated, and still lags far behind our acquaintance with their physiological actions. Only two of them, substances of low molecular weight and relatively simple structure, have been prepared synthetically. In respect to these two, then, the organic chemist has again come to our rescue and both the experimentalist and the manufacturer are now free to accept their deliverance from the products of the slaughter house.

The first of these hormones to be conquered is the one that is elaborated in the so-called medulla of the suprarenal capsules, small yellowish structures, each shaped like a cocked hat and fitting snugly on top of its corresponding kidney. The two organs together, in a fully developed man, weigh less than a third of an ounce. Life is impossible without them. Like some others of the endocrine organs, notably the hypophysis, they are double structures, fused in the higher animals into what is apparently only one organ consisting of a medullary or inner portion and a cortical or outer portion. This cortical portion contains a hormone, or hormones, more immediately necessary to life than that produced in the medulla. Investigators are now occupying themselves with it and we look forward, I confidently believe, to a successful outcome of their researches.

The medullary hormone is called by various names, as adrenin, suprarenalin, suprarenin, adrenalin and

epinephrine, the latter having been adopted by the United States Pharmacopoeia as the official designation. This name was coined by me thirty years ago at a time when I supposed that the form in which I had succeeded in isolating it represented the base as it actually exists in the capsules.

Without going into the details of earlier attempts to isolate the principle, all of which I have described in a historical paper published in 1903 (*Amer. Jour. Pharm.* 1903 *75,* p. 301), I hope that you will permit me to say a few words about my own investigations towards its isolation. With the assistance of the late A. C. Crawford I succeeded in separating the hormone from its numerous tissue concomitants in the form of a benzoyl derivative. On decomposing this benzoyl derivative with hot dilute sulphuric acid in an autoclave we obtained the active principle in the form of a sulphate which possessed the characteristic physiological activities of suprarenal extracts and reacted, furthermore, with a series of chemical reagents in a manner that is quite specific for such extracts and limited to them. The principle as obtained by saponification of the benzoyl derivative was thrown out of its solution by means of ammonia in the amorphous state and was shown to be a weak base. A picrate, a bisulphate and other salts of it were prepared, all of which were shown to possess a high degree of physiological activity. An acetyl derivative, a phenylcarbamic ester and other derivatives were also prepared and certain degradation products of the base were isolated and studied. Without giving any further details of this earlier work, which occupied my time for a number of years, I will merely state that the elementary composition of the base was established by analysis of several derivatives, including a sulphate, and was stated to be represented by the formula $C_{17}H_{15}NO_4$ (*Zeit. f. physiol. Chem.,* 1899, xxviii, 318).

After I had completed the above described investigations and while I was still endeavoring to improve my processes I was visited one day in the fall of 1900 (as I recall it) by the Japanese chemist, J. Takamine, who examined with great interest the various compounds and salts of epinephrine that were placed before him. He inquired particularly whether I did not think it possible that my salts of epinephrine could be prepared by a simpler process than mine, more especially without the troublesome and in this case wasteful process of benzoylating extracts of an animal tissue. He remarked in this connection that he loved to plant a seed and see it grow in the technical field. I told Takamine that I was quite of his opinion that the process could no doubt be improved and simplified. At this very time also, v. Fürth had just prepared an amorphous, highly active, indigo-colored compound of the active principle, which he named suprarenin, but no analytical data were given and no empirical formula for his principle was established.

Takamine prepared suprarenal extracts more concentrated than mine, and without first attempting to separate the hormone from its numerous concomitants by benzoylating or otherwise, simply added ammonia —the reagent that I had so long employed—to his concentrated extracts, whereupon he immediately obtained the native base in the form of burr-like clusters of minute prisms in place of my amorphous base. I have often been asked why I had not myself attempted to solve the problem in this very simple fashion. The truth is that I had tried to do so but always found that the dilute extracts tested simply turned pink in a short time on the addition of ammonia without depositing a base, either crystalline or amorphous. Inasmuch as even very dilute solutions of the salts obtained by me on saponifying the benzoyl derivatives always gave a precipitate with ammonia, I fell back on the hypothesis that other constituents of the impure extracts prevented its precipitation by ammonia from my dilute native extracts—an erroneous assumption. Takamine's success was due to the employment of ammonia on very highly concentrated, though impure, extracts. The fact that my amorphous base could be precipitated from even highly dilute solutions was, as I soon found, due to the fact that one benzoyl radical had not been removed during the saponification. Takamine adopted the empirical formula $C_{10}H_{15}NO_3$ as the "probable empirical formula" of his substance, which was immediately patented in this country and manufactured, greatly to the advantage of medicine. I was soon able to demonstrate that my epinephrine—$C_{17}H_{15}NO_4$ —had retained a single benzoyl radical, C_6H_5CO, that had resisted saponification and could only be removed from the base by drastic treatment with strong acids and heat, a treatment which at the same time obliterated every trace of the characteristic physiological action of the hormone (Johns Hopkins Hospital Bulletin, 1901, vol. xii, p. 337). I suspect that the retained radical was attached to the imide nitrogen of the side chain of the molecule—an unusual circumstance in any event. Subtracting the molecular weight of the retained radical from my original formula, $C_{17}H_{15}NO_4$, leaves $C_{10}H_{10}NO_3$, which formula is very close indeed to that assigned by Takamine to his crystalline base, and Aldrich, who had been my assistant and who, coincidently with Takamine and quite independently of him, also discovered that the base is obtainable in crystalline form when ammonia is added in sufficient quantity to a highly concentrated suprarenal extract, wrote, with-

but knowing at the time that I had already discovered the concealed radical: "It is interesting to note in this connection that if we subtract a benzoyl residue from Abel's formula for epinephrin—$C_{17}H_{15}NO_4$—we obtain a formula $C_{10}H_{10}NO_3$ which is not far removed from that of adrenalin." (*Amer. Journ, Physiol.*, Vol. V, p. 461).

I venture to say in extenuation of the blunders of a pioneer in this field that the results obtained by me and my close approximation to the true elementary composition of the hormone were not due to chance, but could have been obtained only from the study and analysis of a series of fairly pure chemical individuals. Every one of these derivatives had, however, as already stated, retained a single benzoyl radical. The efforts of years on my part in this once mysterious field of suprarenal medullary bio-chemistry, marred by blunders as they were, eventuated, then, in the isolation of the hormone, not in the form of the free base but in that of its monobenzoyl derivative. Aldrich finally established the true empirical formula, $C_9H_{13}NO_3$, the correctness of which was afterwards conclusively verified by others abroad.

I can not look back on my own poor efforts to elucidate the chemical constitution of the compound with pleasure. After the preparatory pioneer work thus far outlined there followed the brilliant researches, in respect to the chemical constitution of the hormone, of the chemists, Dakin, Jowett, Pauly, Friedmann, Stolz and Flächer, which have finally culminated in the synthetic production, first of the racemic and later of the laevo-rotatory form, as produced in the animal organism itself. The work of these chemists has shown that the suprarenal medullary hormone is an aromatic amino-alcohol, dihydroxy-methyl-amino-ethylol-benzene,

$$C_6H_3(OH)_2 \cdot CHOH \cdot CH_2 \cdot NH \cdot CH_3.$$

The cells of the medullary portion of the suprarenal gland are intimately related in their origin to the sympathetic nervous system, and we are not surprised therefore to find their secretory product, adrenalin or epinephrine (U. S. P.), has a pharmacological and quite specific affinity for the sympathetic nervous system—the thoracic-abdominal part of the autonomic nervous apparatus. The changes induced by epinephrine in the activity of the various organs innervated by this system are in all respects like those that are brought about when the sympathetic fibers controlling these organs are stimulated by an electric current. A small quantity of the hormone administered intravenously will cause vaso-constriction, increased rapidity of heart action, dilatation of the pupil, relaxation of constricted bronchioles, inhibition of the peristaltic movements in the alimentary canal, contraction of the pyloric and ileo-coecal sphincters, increased motility of the pregnant uterus and mobilization of the glycogen of the liver with a resultant glycosuria. We have here then an example of a definite chemical principle of known structure which, when carried by the blood to a terminal point of the sympathetic system, induces exactly those alterations that follow electrical stimulation of the sympathetic fibers that pass to these terminal points. In more technical pharmacological terms, the hormone stimulates, sensitizes or acts in an inhibitory manner on sympathetic myoneural or adenoneural, junctions of the sympathetic nervous system. Because of this highly specific action this hormone and the many others of its class that have been isolated in recent years from various animal, plant and bacterial products have been given the name of sympathomimetic amines.

I can not pause to give an account of the various beneficial uses which several of these sympathomimetic amines have found in medical practice. Nor can I enter upon a chemical or pharmacological analysis of these numerous, naturally occurring or synthetically prepared, biologically very important substances that are classified with epinephrine as phenylalkyl- or phenylalkanolamines. This group is only one of many groups of physiologically more or less active substances grouped together as a class of biogenous amines.

It is worth while pointing out in this connection that from the structural point of view a whole series of alkaloids, as hydrocotarnine, anhalamine, anhalonidine, papaverine, laudanine, bulbocapnine, corydine, berberine, canadine, cryptopine, protopine and many others can be brought into genetic relationship with the phenylalkylamines above referred to, as has been outlined by Elger.

I may conclude this section of my lecture by a brief description of a plant principle, ephedrine, closely related in structure and physiological action to the hormone of the suprarenal medulla. For more than 5,000 years the Chinese have used the stems of *Ephedra vulgaris,* under the name of Ma huang, as a medicine famed among them as a diaphoretic, a circulatory stimulant, a sedative in cough and an antipyretic. The Japanese chemists Yamanashi and Nagai first isolated from Ma huang a derivative of phenylethylamine and named it ephedrine. The chemical structure of this laevo-gyrous plant base has been determined and is evident from its formula,

$$C_6H_5 \cdot CH \cdot OH \cdot CH \cdot CH_3$$
$$\qquad\qquad\qquad\qquad\quad |$$
$$\qquad\qquad\qquad\qquad NH \cdot CH_3$$

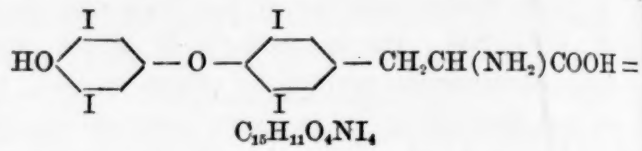
1-phenyl-1-hydroxy-2-methylaminopropane. It will

be noted, on comparing this structural formula with that of epinephrine, that ephedrine contains two asymmetric carbon atoms as compared with the one of epinephrine, which latter also differs in containing two phenolic hydroxyl groups in the ortho-position to each other, making it much more susceptible to oxidation than ephedrine. Ladenburg and Oelschlägel, who determined the chemical structure of ephedrine, have succeeded in isolating from the *Ephedra vulgaris* of Europe a stereoisomer, pseudo-ephedrine, which is not, strictly speaking, an optical antimere in its configuration. Its dextro-rotation is due to a difference in the spatial arrangement of the alcoholic hydroxyl group of the above structural formula. The four possible isomers of ephedrine have been prepared synthetically and isolated and an extensive literature has already appeared in connection with their chemical and pharmacological properties and with the medical uses of the laevo-gyrous isomer, ephedrine. The pharmacological action of this plant phenylalkanolamine is qualitatively identical with that of the suprarenal base, epinephrine; in other words, it is a typically acting sympathomimetic amine. It is less active physiologically than the latter, but its effects are more prolonged. In the form of ephedrine sulphate it has already been found to be of great value in nasal operations and in ophthalmology. Its ultimate value in serious diseases of the heart, in shock, hypotension and other pathological states is now being made the subject of numerous investigations.

THE HORMONE OF THE THYROID GLAND

A second hormone, the chemical constitution of which has only recently been unravelled, is that produced by the thyroid gland, a small trilobed organ set astride the windpipe, below the larynx, and weighing in man 35 grams or 1¼ ounces. In this connection I may add that we are also endowed with a number of very small endocrine organs, the parathyroids, usually four in number, two on each side of the neck, closely adherent to the dorsal surface of each lateral lobe of the thyroid gland. While the thyroid gland of man weighs about 35 grams or 1¼ ounces, the four parathyroids, each about the size of a hempseed, weigh together only half a gram or 7 to 8 grains. These minute glands, like the thyroid itself and most of the other organs of internal secretion, have an unusually good blood supply and are essential to life, one of their known functions being that of controlling in some as yet undefined manner the chemical combinations of the calcium in the tissues. Their hormone has not yet been isolated.

The hormone of the thyroid gland was first isolated in crystalline form by E. C. Kendall in 1914, and was named thyroxine by him. A year ago C. H. Harington, of University College Hospital, London, described an improved method for the separation of thyroxine from the thyroid tissue and by the brilliant application of well-known methods of break-down and synthesis obtained an iodine-free degradation product, desiodothyroxine, differing only from the natural hormone in being devoid of the four iodine atoms present in the latter. Harington next succeeded in working out the constitution of this desiodothyroxine and found it to be the p-hydroxyphenyl ether of tyrosine. Next, Professor Barger and he conjointly prepared in a masterly manner a series of organic derivatives which were utilized in finally effecting the synthesis of the hormone in its racemic form. The brilliant work of these investigators, carried out along classical chemical lines, has now incontestably established the constitution of the hormone as being β-[3, 5-diiodo-4-(3′, 5′-4′-hydroxyphenoxy) phenyl]-α-aminopropionic acid, as represented by the following formula:



$C_{15}H_{11}O_4NI_4$

Synthetic thyroxine, as prepared by Harington and Barger, is obtained in the form of a crystalline precipitate consisting of rosettes and sheaves of colorless needles. The compound is insoluble in water and the usual organic solvents, soluble at room temperature in solutions of the alkali hydroxides, provided their concentration be not too high. It dissolves in sodium carbonate solution only on boiling and is soluble in 90 per cent. alcohol containing either an alkali hydroxide or a mineral acid. Sodium, ammonium and barium salts have been prepared which agree in their properties with the corresponding salts of the natural product. The identity of the synthetic product with the natural hormone has thus been conclusively established by the brilliant researches of Harington and Barger.

Professor D. Murray Lyon, of Edinburgh, has studied the effects of synthetic thyroxine on two myxoedematous patients whose basal metabolism rates were respectively 32 and 45 per cent. below normal. After intravenous administration to each of the two of a total dose of 14 mgs. of the hormone, given in divided doses over a period of six days, the basal metabolism of the one rose to within 6 per cent. of normal and that of the other to 3 per cent. above normal. It is concluded, therefore, that the effect of synthetic thyroxine in raising the basal metabolic rate of these two patients is quantitatively similar to that reported by Boothby and Sandiford, of the Mayo Clinic, in 1924, for natural thyroxine.

THE PANCREAS AND ITS HORMONE, INSULIN

Of the endocrine glands which are now being so actively investigated, I have selected for further discussion the pancreas and its internal secretory product, insulin. Needless to say that within the brief time left I can do no more than just touch on a few of the important researches that constitute the historical background for our present conception of the indispensable rôle of this gland in carbohydrate metabolism. There are four important milestones in the history of carbohydrate metabolism which can receive but the barest mention here.

I. The epoch-making researches of Claude Bernard in relation to the functions of the liver and pancreas and more especially with reference to their rôle in carbohydrate metabolism constitute the first of the four milestones. Bernard, in his masterful and logical way, worked out the fact that the liver is capable of polymerizing dextrose into a starch—or dextrin-like substance which he named glycogen because the hepatic tissue is able, through the agency of a ferment, to reconvert it into sugar. His findings caused Bernard to view the liver as an organ of internal secretion (and he was one of the first to use this term), that is, an organ which manufactures in its cells a product which can be converted into a substance transportable by the blood to all parts of the body and utilizable by the tissues. Bernard, not content merely with proving the existence of such a product in the liver, set out to extract and to isolate it from this organ in pure form, a feat which he accomplished in 1857 after many years of preliminary work. Having now isolated glycogen, Bernard determined the conditions under which it is formed and is reconverted into sugar, and before long he was able to show that the reciprocal relationship between glycogen and glucose in the animal organism is entirely analogous to that existing between starch and sugar in the metabolism of plants. The name animal starch, by which glycogen is frequently called, is therefore well taken.

II. The second important development in this field came when the pathologist Langerhans, then a young investigator in Virchow's laboratory in Berlin, discovered (1867–69) that there are contained in the pancreas groups of cells situated between the acini and markedly different from those of the ordinary glandular type. These groups, usually round, are composed of small, irregular, polygonal cells with a round nucleus and a homogeneous refractive cell body. Numerous observers have verified this discovery and they have been designated ever since as the islands of Langerhans or the islet tissue. These islands of Langerhans are the seat of formation of the pancreatic hormone, which has been appropriately named insulin in accordance with the suggestion first made by the Belgian, de Meyer, in 1909 and independently by the distinguished physiologist, Schäfer, in 1916 and adopted at the latter's suggestion by the Toronto workers. But the proof that the islet tissue of the pancreas produces the hormone was not established until near the close of the last century, and it required the joint labors of many investigators to establish this point with certainty.

In certain teleostean fishes, the islets, homologous in structure and in their function with those of Langerhans, exist as organs quite separate from the pancreas, and an additional link in the chain of evidence in support of the theory that the islet cells alone can produce insulin was furnished by the Toronto investigators, Macleod and his associates, who extracted the hormone from these specialized teleostean organs and found that it possessed the physiological properties of the insulin prepared from the pancreas of beeves. The islets are more abundant in the pancreas of the higher animals than was formerly believed to be the case. In the entire pancreas of the guinea pig, according to Bensley, as many as 56,000 islets have been counted, "so that the endocrine tissue, instead of being rather scant, as it has usually been thought to be, is rather abundant" (Macleod).

III. A third great step forward was taken in 1889–91. In those years the clinicians v. Mering and Minkowski discovered that complete removal of the pancreas from dogs is followed by a diseased state which is practically in all respects like that seen in human diabetes mellitus. This clean-cut piece of experimental work, with the consequences that are logically deducible from it, constitutes one of the greatest achievements in this field since the discovery of glycogen and the demonstration of its physiological properties by Claude Bernard fifty years before. These consequences, indeed, played the chief rôle in the establishment of the proof outlined above under the heading (II) that the islets of Langerhans are the seat of formation of insulin, and furthermore, when taken in conjunction with the subsequent findings of pathologists, as Opie and others, they forced on men's minds the conviction that the cause of that frequently occurring and serious disease, diabetes mellitus, must be referred to an inadequate functioning of the islets.

The crucial demonstration by v. Mering and Minkowski that ablation of the pancreas leads inevitably to diabetes naturally served as a great impetus to further research which confirmed their work and paved the way for the fourth great historical event in this field, presently to be described. Leaving out here all reference to the investigations of about twenty workers in the decade or two following the discovery of v. Mering and Minkowski, let me speak very briefly

of the results obtained by workers in this field closer to our own time, results that almost succeeded in giving us insulin 15 years ago. The Toronto investigators have, in a very generous spirit, given full credit to the unsuccessful attempts of their predecessors to prepare serviceable extracts of the pancreas. In 1908 Zuelzer prepared an alcoholic extract from the pancreas of recently fed animals and obtained rather striking results from its use on a pancreatectomized dog and on eight diabetic patients. It is interesting to note, in studying Zuelzer's protocols, how greatly both the output of urinary sugar and of the acetone bodies was reduced in his patients as the result of the intravenous injection of his preparation. Untoward symptoms, such as a rise of temperature and chills, appeared both in Zuelzer's patients and in those of Forschbach, another clinician who tried Zuelzer's extract. In the opinion of the latter, the alleviation of the symptoms in diabetic patients was due rather to the febrile reaction induced by the injections than to a specific action of the hormone assumed by Zuelzer to be present in his extracts, and so it fell out that the successful use of pancreatic extracts for the treatment of diabetes has had to wait until our day for men equipped with newer methods and who, above all else, based their conclusions both on evidence obtained from well controlled animal experimentation and on clinical experience with diabetic patients.

E. L. Scott, who worked in this city in 1911–12 in Professor Carlson's laboratory, also came very close to obtaining a pancreatic extract that might have been serviceable, had it been tried out on human beings, since, by his method of preparation, blood-pressure lowering substances were removed. Scott's extracts, when injected intravenously into completely pancreatectomized dogs, diminished temporarily the sugar excretion and lowered the D:N ratio of the urine. Unfortunately, however, this investigator did not properly interpret his findings, inasmuch as he concluded that it does not follow that the effects induced by his extracts were due to the presence in them of the internal secretion of the pancreas. In 1913 Murlin and Kramer, in their study of the effects of pancreatic extracts on glycosuria, were led to the conclusion that neither their extracts nor the transfusion of normal blood "is as yet of any practical importance in restoring to the depancreatized dog the ability to burn sugar." Kleiner, using emulsions of the dog's pancreas infused slowly into a vein of a depancreatized dog, observed a temporary but marked decrease in the blood and urinary sugars and regarded his findings as furnishing evidence in support of the endocrine theory of experimental diabetes.

Other attempts to prepare an extract of the pancreas that would be serviceable in lowering the blood and urinary sugars and in ameliorating the symptoms of depancreatized animals and of human diabetics can not be detailed here.

IV. The numerous discoveries since Claude Bernard's day, grouped together under three periods as above, constituted the indispensable foundation for a fourth step—the preparation of an effective and stable extract that would unfailingly, or with rare exceptions, restore completely to health persons, old and young, sufferers from and often the early victims of that hitherto unconquerable malady, diabetes mellitus.

All the world knows of the brilliant achievements of Banting, Best, Macleod and Collip and their collaborators, acting on an original suggestion of Banting, that have led to the fourth great epoch in the combined fields of bio-chemical, physiological, pharmacological and clinical investigation. The results of these talented investigators have been and will continue to be of incalculable value to mankind, and have opened up many new possibilities for the study and better comprehension of the difficult field of carbohydrate metabolism.

This brings me now to a brief account of my own endeavors and those of my collaborators to isolate and separate the true insulin hormone from its numerous concomitants in the therapeutic preparations now employed, serviceable as they are, in the treatment of diabetics. It is a proper aim of the scientist, a mandate even, if I may say so, is laid upon him, wherever it is humanly possible, to isolate and to identify the elusive and indispensable hormones from their complicated mixtures (messes, the chemist would say) in which nature presents them. Once this aim has been realized and the hormone has been separated as a well defined chemical individual, the next steps, such as the study of the constitution of the hormone and its eventual synthesis, if ultimately possible, fall to the chemist. As in all previous instances, the isolation of a hormone as a chemical individual gives to the biochemist and physiologist a cleaner approach for the solution of their problems than when they are compelled to use mixtures of unknown composition.

These studies were made possible through a generous grant from the Carnegie Corporation of New York. The earlier ones are set forth in the following publications from my laboratory: Abel and Geiling, *Journ. Pharmacol. and Exper. Therap.*, 1925, XXV, 423; Abel, Geiling, Alles and Raymond, SCIENCE, 1925, xlvii, 169. They deal chiefly with establishing the fact that sulphur in a labile form is an integral

part of the insulin molecule and that the physiological activity goes hand in hand with the labile sulphur content of the molecule. I next succeeded in obtaining insulin in crystalline form and during the past year its preparation has been so simplified that, starting with commercial preparations such as the dry powder manufactured by the Connaught Laboratories of Toronto (13 units per milligram) or the concentrated liquid extracts furnished by Eli Lilly and Co. and E. H. Squibb and Sons (250–450 units per cc.), the crystals can be obtained in any desired quantity within a very few days. The salient features of the new method, the full details of which are given in *The Journal of Pharmacology and Experimental Therapeutics*, 1927, xxxi, 65, can be seen from the following brief description of a typical experiment in which, starting with 2.001 grams of a Toronto powder evaluated at 13 units per milligram, there was obtained a total of 0.5284 gram of crystalline insulin. Various samples of these crystals have been submitted to the insulin committee at Toronto for standardization, but owing to the press of other work the committee has not as yet been able to make a report on them. Our own standardizations of a recrystallized preparation against the International Standard Powder gave us a conservative value of 40 international units per milligram.

To the powder, dissolved in 20 cc. of 10 per cent. acetic acid, was added 80 cc. of brucine acetate solution (1 gram of base in 18 cc. of N/6 acetic acid) and then 40 cc. of 13.5 per cent. aqueous pyridine; the resulting "pyridine precipitate" was centrifuged off and the clear fluid treated with 40 cc. of 0.65 per cent. aqueous ammonia. The "ammonia precipitate" so obtained was likewise centrifuged off and the fluid set aside to crystallize in an Erlenmeyer flask. Next morning the walls and bottom of the flask were found lined with crystals which, after washing and drying, weighed 0.2776 gram. The "pyridine" and "ammonia" precipitates treated in the same way gave further crops of 0.1458 and 0.0614 gram, respectively, and a final crop of 0.0436 gram was obtained from the residue left by evaporating in a current of air at room temperature the mother liquors from the preceding fractions. The total yield of crystals was thus 0.5284 gram.

Starting with liquid preparations, the procedure is the same except that the crude insulin is first precipitated with insulin as described in earlier papers.

Measurements with the Michaelis' nitrophenol indi-

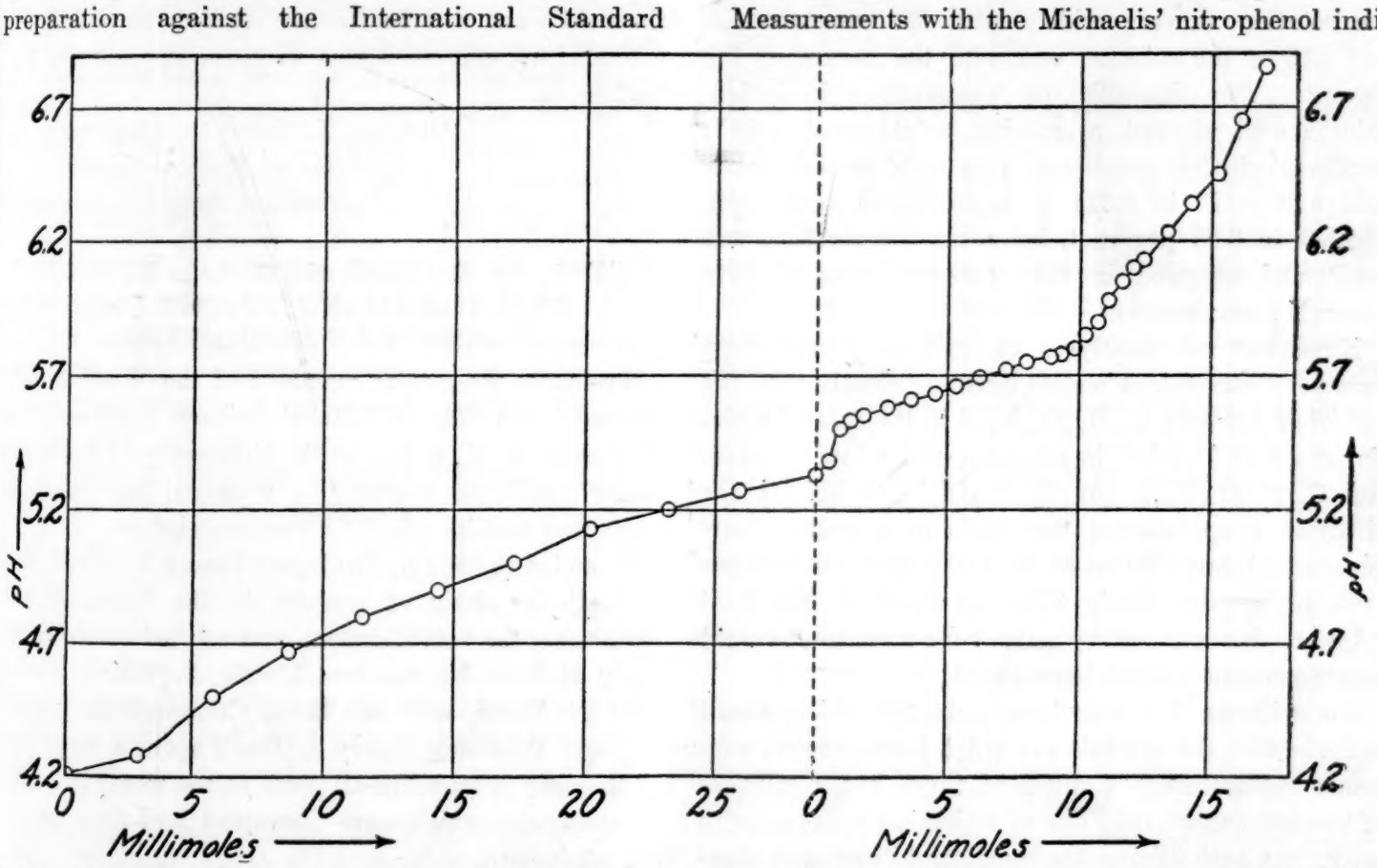


FIG. 1. TITRATION CURVE SHOWING pH VALUES OF A MIXTURE OF 40 CC. OF BRUCINE ACETATE SOLUTION (1 GRAM OF BRUCINE ALKALOID DISSOLVED IN EACH 18 CC. OF 0.132 N ACETIC ACID) AND 10 CC. OF 1.317 N ACETIC ACID UPON THE ADDITION OF PYRIDINE AND AMMONIA.

A total of 20 cc. of 1.441 N pyridine was added (left portion of curve), followed by 38 cc. of 0.444 N ammonium hydroxide (right side of curve). The amounts of the bases added are plotted in millimoles. The hydrogen-ion concentrations were estimated colorimetrically with Michaelis' nitrophenol indicators, using 0.1 cc. of buffer mixture for each determination.

cators as well as with the quinhydrone electrode showed that the pH of the solution from which the insulin separated in crystalline form was 5.55–5.65. After centrifuging off the "ammonia precipitate" it may be necessary to add a little more ammonia to the fluid to bring it to the proper hydrogen-ion concentration before setting it aside to crystallize. The accompanying curve shows how the pH of a mixture of acetic acid and brucine, made up in the proportions employed in this method, varies with the gradual addition of the usual amounts of pyridine and ammonia.

The crystals are apparently dimorphous and fall into two general groups: (1) Crystals with well-defined double refraction, of negative character, with several habits, in the rhombohedral class; (2) crystals of a more equant habit, often with clearly defined crystal edges and no double refraction.

They give the Pauly, Millon, biuret and ninhydrin reactions but not the Voisonet, Hopkins-Cole or Acree tests for tryptophan or the Sullivan test for free cystine and cysteine.

The many solutions (in acetic acid, hydrochloric acid and ammonia) examined polarimetrically were always found to be laevo-rotatory, the magnitude of the rotation varying widely with the concentration and pH of the solution and with the nature of the solvent. For example, one preparation in hydrochloric acid showed a specific rotation of $-40°$; another, twice recrystallized, gave $-30°$ in N/6 acetic acid and $-17°$ in 0.011 N hydrochloric acid; with another in 0.65 per cent. ammonia the rotation was $-48°$ and changed in the course of several days through a maximum at $-63°$.

Numerous microanalyses on various preparations gave very concordant results agreeing closely with the empirical formula $C_{45}H_{69}O_{14}N_{11}S$ in the case of material dried at 105–20° in nitrogen under low pressure and $C_{45}H_{75}O_{17}N_{11}S$ (or $C_{45}H_{69}O_{14}N_{11}S \cdot 3H_2O$) for air-dried preparations; the labile or so-called "carbonate" sulphur content of the latter is about 1.10 per cent. or approximately 37.5 per cent. of the total sulphur. No satisfactory solvent for molecular weight determinations has yet been found.

No evidence has ever been obtained which would indicate that the crystals are not a homogeneous substance crystallizing in different types but a mixture of two substances, only one of which is physiologically active but both having the same solubilities and identical or nearly identical empirical compositions.

JOHN J. ABEL

THE JOHNS HOPKINS UNIVERSITY

SCIENTIFIC EVENTS

A STUDY OF ASCARIASIS

THE American Child Health Association has arranged to furnish support for an extended investigation of ascariasis, an infestation widely prevalent especially in children. Through the courtesy of the Johns Hopkins University, the work will be conducted under the direction of Professor W. W. Cort, of the department of helminthology of the School of Hygiene and Public Health, under the auspices of the division of medical sciences, National Research Council, through its Committee on Medical Problems of Animal Parasitology.

Professor Cort and his selected staff will investigate the life history of the parasite, its mode of transmission, the incidence of infestation, the effects upon infested animals and man and the methods of treatment and control. The central feature of the program will be the relation of this parasite to the health and development of children, since it is in young children that the infestation is the heaviest and the injury produced the greatest. Studies are to be undertaken in the School of Hygiene and Public Health, with the admirable facilities there available. Most of the investigations, however, will be in the field for which stations will be established at strategic points in the United States and their territories and insular possessions. The information and material yielded by the field work will be further studied, amplified and extended by, and correlated with, the investigations in Baltimore.

HOWARD T. KARSNER, *Chairman,*
Division of Medical Sciences,
National Research Council

GIFT OF WARD'S NATURAL SCIENCE ESTABLISHMENT TO THE UNIVERSITY OF ROCHESTER

THROUGH the gift of members of the Ward family, ownership of Ward's Natural Science Establishment, Rochester, N. Y., passes to the University of Rochester under conditions enabling its museum features to be preserved and its scientific work carried on.

Founded in 1862 by Professor Henry A. Ward, then holding the chair of geology in the University of Rochester, the establishment was carried on from the early eighties by the late Frank A. Ward, son of Levi A. Ward, who had largely financed the undertaking. Professor Henry A. Ward spent a large part of the year in travel in all parts of the world in search of specimens which were assembled and arranged at the workshops.

The following paragraphs are taken from a statement on the gift made by Raymond N. Ball, treasurer of the University of Rochester:

The University of Rochester feels greatly honored in being asked to accept the splendid foundation which the Ward family proposes to found in memory of Frank A. Ward.

It was the energies and business ability of Frank A.

Ward in financing and managing Ward's Natural Science Establishment from the early eighties until the time of his death that permitted Professor Henry A. Ward while alive to devote his full time and experience in the field, supplying the establishment with materials and thereby making such materials available for distribution to the scientific world. The university cherishes the memory of both of these eminent men who have contributed so much to the field of science. It accepts with a sense of keen responsibility the trusteeship of the Frank A. Ward Foundation, which is being founded so unselfishly by the living members of the Ward family.

In accepting this trust the university recognizes the obvious advantage which will accrue to its own scientific departments, both instructors and students, in continuing and controlling such a vast collection of scientific materials gathered from all parts of the world. It will also bring the university into intimate association with the leading scientific establishments both in this country and abroad. Furthermore, the university appreciates Mr. Hawley Ward's willingness to remain as director of the business interests of the institution.

Professor Henry A. Ward, the founder of the museum, was the second instructor in our geology department, succeeding Professor Chester Dewey in 1861 and serving in that capacity until 1875. The University of Rochester, chiefly because of Professor Ward, attracted considerable attention by its scientific offerings at that time, since it was the first college in America, if not in the world, to establish a course in science on an equality with the classical course. Furthermore, the university's museum collection of about 40,000 specimens purchased in 1862 was made by Professor Ward and was at that time the largest collection in geology, mineralogy, petrography and paleontology in America. In fact, few colleges at the present time are said to possess as good display and teaching collections. That this early tradition may be revived and our present facilities further strengthened by the permanent acquisition of the Ward's Establishment is naturally very gratifying.

The success of the greater university campaign in 1924 makes it possible for the university to accept this foundation in that the collection, now owned by the university, and such specimens from the present collection of the Ward's Natural Science Museum which are and can be used for teaching purposes will be most effectively used in the new museum which it is planned to build in connection with the biology and geology building on the new site for the college for men. This museum will be open to the public.

SCIENTIFIC LECTURES AT THE FRANKLIN INSTITUTE, THE CALIFORNIA ACADEMY OF SCIENCES AND THE UNIVERSITY OF CHICAGO

FOLLOWING is the schedule to January, 1928, of lectures to be given at the Franklin Institute, Philadelphia:

October 19—*Engineering contributions of the gyroscope:* ELMER A. SPERRY, Esq., president, Sperry Gyroscope Company, Brooklyn, New York.

October 27—*Animal mechanics:* PROFESSOR ULRIC DAHLGREN, department of biology, Princeton University.

November 10—*Modern research on the structures of metals:* PROFESSOR WHEELER P. DAVEY, department of chemistry, Pennsylvania State College.

November 16—*Automatic train control:* A. H. RUDD, Esq., chief signal engineer, The Pennsylvania Railroad.

December 1—*The design, construction and equipment of the Broad Street subway:* H. E. EHLERS, Esq., director, department of city transit, City of Philadelphia.

December 8—*Illumination in the industries:* PROFESSOR DUGALD C. JACKSON, department of electrical engineering, Massachusetts Institute of Technology.

December 21—*Talking and synchronized motion pictures:* WILLIAM H. BRISTOL, Esq., president, The Bristol Company, Waterbury, Connecticut.

The California Academy of Sciences has announced lectures to be given in the auditorium of the academy's museum in Golden Gate Park, at three o'clock on Sunday afternoons as follows:

October 2—*Popularizing science through the public press:* DR. WILLIAM EMERSON RITTER, president, Science Service, Washington, D. C. Illustrated.

October 9—*Golden Gate park as a botanical garden:* MISS ALICE EASTWOOD, curator, department of botany, California Academy of Sciences, San Francisco. Illustrated.

October 16—*Home life of the Alaska willow ptarmigan:* JOSEPH DIXON, economic mammalogist, museum of vertebrate zoology, University of California, Berkeley. Illustrated.

October 23—*California's forest resources:* J. W. NELSON, assistant district forester, United States Forest Service, San Francisco. Illustrated.

October 30—*The work of "The Save the Redwoods League":* JOSEPH D. GRANT, vice-president board of trustees, California Academy of Sciences, San Francisco. Illustrated.

At the close of each lecture a moving picture film will be shown illustrating some phase of natural history.

On Friday evenings members of the scientific departments of the University of Chicago will give a series of lectures in the Lake View Building lecture room on the general subject: "The Nature of the World and Man," as follows:

October 14 and 21—*Astronomy:* WILLIAM DUNCAN MACMILLAN, department of astronomy.

October 28 and November 4—*The origin and early stages of the earth:* ROLLIN T. CHAMBERLIN, department of geology.

November 11 and 18—*Geological problems of the earth's history:* J HARLEN BRETZ, department of geology.

December 2—*The message of a beam of light:* HARVEY BRACE LEMON, department of physics.

December 9—*The dance of molecules and flight of electrons:* PROFESSOR LEMON.

December 16 and 23—*The nature of chemical processes:* JULIUS STIEGLITZ, department of chemistry.

THE DEDICATION OF THE CHEMISTRY-PSYCHOLOGY BUILDING OF WITTENBERG COLLEGE

THE dedication of the new chemistry-psychology building of Wittenberg College, Springfield, Ohio, will take place on October 21. The dedicatory address for chemistry will be given by Dr. Edgar Fahs Smith, provost-emeritus of the University of Pennsylvania, and the dedicatory address for psychology by Dr. J. McKeen Cattell. Honorary degrees will be conferred, followed in the evening by a reception and a banquet, when Dr. E. E. Slosson will be the speaker.

In connection with the dedication a conference on chemistry will be held on October 20, 21 and 22 and a symposium on the "Psychology of Feelings and Emotions" has been arranged from October 19 to 22, by Dr. Martin L. Reymert, professor of psychology and director of the laboratory and editor of *The Scandinavian Scientific Review*.

The preliminary program follows:

CONFERENCE ON CHEMISTRY

Honorary Chairman—E. E. Slosson.
Chairman—A. F. Linn.

Thursday, October 20

Forenoon session

Inspection of the Chemistry Building.
W. D. Harkins, "Cosmic Chemistry."

Afternoon session

Wm. E. Henderson, "The Place of Chemistry in the Schools of the Orient."

E. C. Franklin, "The Ammonia System of Compounds."

Evening session

Colonel H. L. Gilchrist, "Chemistry in War and its Medical Significance."

Friday, October 21

Forenoon session

H. P. Cady, "Physical Chemistry, the Doorkeeper."

Alexander Silverman, "The Future of Chemical Education."

Afternoon session

General academic program.
Dedication of the Chemistry Building.
Edgar Fahs Smith, dedicatory address.

Evening session

E. E. Slosson, "The Human Side of Chemistry."

Saturday, October 22

Forenoon session

H. N. Holmes, "The Place of Research in College."

Wm. McPherson, "The Contributions of Ohio Chemists."

SYMPOSIUM ON FEELINGS AND EMOTIONS

Honorary Chairman—James McKeen Cattell.
Chairman—Martin L. Reymert.

AMERICAN PSYCHOLOGISTS

(To be present in person)

James McKeen Cattell, "Early Psychological Laboratories." (General inaugural address.)

Herbert S. Langfeld, Princeton, "The Rôle of Feelings and Emotions in Esthetics."

Walter B. Cannon, Harvard, "Neural Organization for Emotional Expression."

W. B. Pillsbury, Michigan, "Utility of Feelings and Emotions."

Joseph Jastrow, Wisconsin, "The Place of Emotion in Modern Psychology."

C. E. Seashore, Iowa, "A New Approach to the Psychophysics of Emotion."

Albert P. Weiss, Ohio State, "Feelings and Emotions as Forms of Behavior."

D. T. Howard, Northwestern, "A Functional Theory of the Emotions."

William MacDougall, Duke, "The Distinction between Feelings and Emotions."

Knight Dunlap, Johns Hopkins, "Emotions as the Dynamic Background."

L. B. Hoisington, Cornell, "Pleasantness and Unpleasantness as Modes of Bodily Experience."

Margaret Washburn, Vassar, "Emotion and Thought: A Motor Theory of their Relation."

Madison Bentley, Illinois, "Is Emotion More than a Chapter Head?"

Harvey A. Carr, Chicago, "The Differentia of an Emotion."

Morton Prince, Harvard, "Can Emotion be Regarded as Energy?"

Robert H. Gault, Northwestern, "On Pleasurable Reaction to Tactual Stimuli."

H. L. Hollingworth, Columbia, "The Relative Contagion of Emotions."

G. S. Brett, Toronto, "Historical Development of the Theory of Emotions."

Among others who may participate are: R. S. Woodworth and John Dewey, of Columbia; George M. Stratton, California; John S. Terry, of New York; representatives from American Public Health Association and American Child Health Association.

EUROPEAN PSYCHOLOGISTS

(Contributing by specially written papers to be read by proxy.) Wednesday's sessions will be devoted to the reading of these papers.

William Stern, Hamburg, "The Ernst-Spiel in Emotional Life."

Felix Krueger, Leipzig, "The Nature of Feeling: A Systematic Theory."

David Katz, Rostock, "The Feelings of the Child as Expressed in its Conversation with Adults."

Werner Gruehn, Estonia, "Feelings and Emotions in the Psychology of Religion."

Pieron, Paris, "Emotions in Animal and Man."

P. Janet, Paris, "Fear of Action as the Essential Element in the Sentiment of Melancholia."

Carl Joergensen, Denmark, "Elements of Feeling."

F. Kiesow, Turin, "The Feeling-tone of a Sensation."

C. Spearman, London, "A New Method of Investigating the Springs of Action."

F. Aveling, London, "Emotion, Conation and Will."

Ed. Claperède, Geneva, "Feelings and Emotions."

Titles not yet received from the following: Alfred Adler, Vienna; W. Bechterew, Russia; Carl Buehler, visiting professor at Johns Hopkins; E. Jaensch, Marburg, Germany.

SCIENTIFIC NOTES AND NEWS

GENERAL HENRY L. ABBOT, the distinguished army engineer, died on October 2, aged ninety-five years. General Abbot was elected a member of the National Academy of Sciences in 1872.

THE Société Nationale d'Acclimatation de France has presented Dr. Alexander Wetmore, assistant secretary of the Smithsonian Institution, the Isidore Geoffroy Saint-Hilaire medal in recognition of his researches and publications in ornithology.

ON the occasion of the centenary celebration of the University of Toronto, twenty-six honorary degrees were conferred, including the degree of doctor of science on Dr. Frederick James Alway, professor of soil chemistry, University of Minnesota; Sir John Bland-Sutton, past president of the Royal College of Surgeons of England; Dr. Louise D. Cummings, professor of mathematics, Vassar College; Dr. Elizabeth Rebecca Laird, professor of physics, Mount Holyoke College; Dr. William G. MacCallum, professor of pathology and bacteriology, the Johns Hopkins University; Dr. Thomas McCrae, professor of medicine, Jefferson Medical College, and Gaston Leon Ramon, director of the Pasteur Institute Annex. The degree of doctor of engineering was conferred on David Law Hodges Forbes, general manager of the Teck Hughes Mining Company; Thomas Henry Hogg, hydraulic engineer for the Hydro-electric Power Commission of Ontario, and James L. Morris, civil engineer.

AT the founder's day exercises at Lehigh University on October 5, Dr. Karl Taylor Compton, professor of physics at Princeton University, gave an address on "Specialization and Cooperation in Scientific Research." The university conferred on Dr. Compton the degree of doctor of science and on Robert Culbertson Hays Heck, professor of mechanical engineering at Rutgers University, the degree of doctor of engineering.

PROFESSOR MICHAEL I. PUPIN, of Columbia University, will be the principal speaker at the conference of delegates in Easton on October 20, when Dr. William Mather Lewis will be inaugurated as president of Lafayette College.

CLARENCE FELDMANN, professor of electrical engineering at the University of Delft, Holland, was elected president of the International Electrotechnical Commission at the recent meeting of that body in Bellagio, Italy. Though a native of New York City, Professor Feldmann received his technical training at the University of Darmstadt, Germany, and has spent his entire career on the European continent.

DR. WILLIAM HENRY POTTER, professor of operative dentistry in the Harvard Dental School, has been made professor emeritus.

DR. ISABEL S. SMITH, professor of biology at Illinois College, Jacksonville, Ill., since 1905, resigned her position last June. By vote of the college trustees, Miss Smith was made professor of biology emeritus. Her permanent address will be Oberlin, Ohio. Dr. Willis DeRyke has been appointed to the chair.

DR. JOHN S. BOYCE, chief of the Portland, Oregon, office of forest pathology, Bureau of Plant Industry, has been made director of the Northeastern Forest Experiment Station, at Amherst. The station has been in charge of S. T. Dana, who has resigned to become dean of the new school of forestry and conservation at the University of Michigan.

DR. F. E. DENNY, of the Boyce Thompson Institute, has been called to Florida to investigate the possibility of raising crops of winter potatoes in the Everglade district west of Palm Beach. The U. S. Department of Agriculture is cooperating with the Florida Experiment Station in this investigation.

NEW appointments were made by the Medical Fellowship Board of the National Research Council on September 24, as follows: Dr. William C. Austin, in physiological and organic chemistry; Dr. Arthur R. Colwell, in chemistry and physics, leading to internal medicine; Wilton R. Earle, in anatomy; Dr. Edgar F. Fincher, Jr., in neurosurgery; Dr. Louis H. Jorstad, in pathology; Ethel D. Simpson, in physiology; Dr. Richard W. Whitehead, in pharmacology; Dr. Harold G. Wolff, in neurology. Dr. Oran I. Cutler, in pathology, was reappointed.

DR. ALEŠ HRDLIČKA, of the U. S. National Museum, sailed on October 1 for Europe, where he will examine the newest finds of early man in several countries and visit the type sites of Neanderthal man. On November 8 he will read his address, following the award of the Huxley medal to him for important contributions to American anthropological science.

DR. ELLWOOD HENDRICK, curator of the Chandler chemical museum, Columbia University, who has been touring South Africa since June, expects to return to the United States at an early date.

DR. EDWARD J. MENGE, head of the department of biology and zoology at Marquette University, during

the past two months has been giving lectures before a number of South American universities, including the University of Cordoba in the Argentine, the University of Montevideo in Uruguay, the University of Chile in Santiago de Chile and the National Society of Medicine and Surgery in Rio de Janeiro, Brazil. Dr. Menge was inducted as a member of the National Society of Medicine and Surgery of South America, and was made an honorary professor of the University of Montevideo.

THE motor truck expedition to the Canadian Rockies, under the direction of Dr. Charles E. Resser and R. S. Bassler, has returned to Washington with data which will permit the editing for publication of the last work done by Dr. Charles D. Walcott, late secretary of the Smithsonian Institution, on the stratigraphy of the Rockies. Its purpose was to study and correlate the strata from one mountain range to another. The area worked by Dr. Walcott is bounded roughly by the Columbia Valley, Bow Valley and Kicking Horse Valley. With the information obtained this summer, Dr. Resser expects to complete for early publication Dr. Walcott's general account of all his work in the Canadian Rockies.

GEORGE PALMER PUTNAM, explorer and publisher, returned to New York on October 6 after a four months' exploration in Baffin Land.

DR. PAUL BARTSCH, professor of zoology at George Washington University, has returned to Washington after spending two weeks at the Tortugas studying the progress made in the hereditary problems which he is conducting upon mollusks.

PROFESSOR JOHN W. HARSHBERGER has returned from a collecting expedition in South America with five hundred dried specimens of South American plant life, which have been added to the University of Pennsylvania botanical collection. Duplicates have been sent to the New York Botanical Garden and the United States National Museum.

DR. ALEXIS CARREL, of the Rockefeller Institute for Medical Research, returned from his annual summer vacation in France on September 21.

SENATOR GUGLIELMO MARCONI, of Italy, has arrived in New York and will remain in the United States for two weeks to study the recent developments in radio made by American engineers.

PROFESSOR L. K. RAMZIN, director of the Thermotechnical Institute of Moscow, has arrived in the United States to make a study of American electric power stations.

DR. JOSEPH JASTROW, of the University of Wisconsin, will give a lecture at Columbia University on November 14. Another psychological lecture will be given on November 21, when Dr. Stanton Coit, of England, will discuss the mentality of apes. Later Professor H. A. Overstreet, of the department of psychology in the College of the City of New York, will gives a series of four lectures on psychology.

A MEMORIAL to Louis Agassiz Fuertes, lecturer in ornithology at Cornell University until his recent death, is being planned. The memorial will be a bird sanctuary at the head of the lake at Stewart Park, Ithaca. Plans for the development include transformation of the old Cascadilla boathouse into a museum or nature study center.

DR. SAMUEL GARMAN, of the museum of comparative zoology, Harvard University, known for his work in ichthyology and herpetology, died on September 30, aged eighty-four years.

DR. MARTIN S. BRENNAN, professor of astronomy and geology at the Kendrick Theological Seminary, St. Louis, died on October 3, at the age of eighty-two years.

DR. WARREN GARDNER BULLARD, professor of mathematics at Syracuse University, died on February 16, at the age of sixty years.

PROFESSOR GUGLIELMO MENGARINI, one of the founders of the Italian Electrotechnical Association, died recently in Rome.

THE meetings of the International Union of Scientific Radiotelegraphy (U. R. S. I.) opened in Washington on October 10. The discussion covered the work of the various branches of the Union since its last meeting in Brussels in 1922, and plans for future activities. Delegates from nine countries were to attend. A session with scientific papers, which was open to the public was held on October 13 at the building of the National Academy of Sciences.

THE administrative board of the American Engineering Council has been called to meet at York, Pa., on October 20. Sessions will last two days. The president of the council, Dean Dexter S. Kimball, of Cornell University, will preside.

WITH 400 delegates in attendance, representing 70 nations and 41 communication companies, the International Radiotelegraphic Conference of 1927 held its opening session at Washington on Tuesday of this week in the presence of a distinguished gathering. The fundamental purposes of the conference, as described by Mr. Hoover, who is presiding, are "to arrive at such modifications as may be necessary in our existing international treaties to promote the wider use, reduce the conflicts and stimulate the

further progress of radio in international communications."

THE twentieth annual Electrical and Industrial Exposition opened on October 12 at the Grand Central Palace, New York City.

THE semi-annual meeting of the Upper State Psychologists will be held at Colgate University on October 21 and 22. The second morning there will be a trip and special clinic at the Utica State Hospital for the Insane. Walter S. Hunter, professor of genetic psychology at Clark University, will be the main speaker.

THE New England conference of the American Association of Museums opened at the New Eastland Hotel, Portland, Maine, on October 6.

THE first meeting of the Johns Hopkins Medical Society for the academic year 1927–28 was held on October 10 in the auditorium of the school of hygiene. The meeting was dedicated to the memory of Lord Lister. There were to be several short talks on various phases of Lister's life and work, leading up to the principal address of the evening by Dr. John Stewart, professor of surgery, Dalhousie University Medical School, Halifax, Nova Scotia. Professor Stewart was senior house officer under Lister in London. Dr. W. G. MacCallum, who represented the National Academy at the Lister Centenary Celebration, described that celebration in one of the briefer talks. Dr. E. K. Marshall, Jr., spoke on Lister's contributions to physiology and Dr. W. W. Ford addressed the meeting on Lister's contributions to bacteriology.

AN International Physical Congress was recently held at Como, Italy. Among well-known scientific men who took part were Rutherford and Aston, of England; von Laue, Franck, Gerlach, Stern, Sommerfeld and Born, of Germany; Cabrera, of Spain; Bohr, of Denmark; Debye and Schrödinger, of Switzerland; Cotton, of France; Corbino, Majorana and Volterra, of Italy; McLennan, of Canada, and Langmuir, Millikan and Wood, of the United States. Topics dealt with included radioactive atoms and rays, molecular dissociation, magnetic susceptibility of alkaline vapors, magnetic properties of palladium and platinum, sound-waves of 300,000 cycles a second and cosmic rays.

THE Eighth International Horticultural Congress opened its first session on September 20 in Vienna, under the presidency of the Chancellor, Dr. Sepel. The meeting marked the one hundredth anniversary of the Austrian Horticultural Society. Sixteen countries were represented by 400 delegates, according to the London *Times*. Among the questions to be discussed at the congress were the conclusion of an international agreement on a uniform horticultural nomenclature and exact regulation of the naming of novelties (not newly discovered botanical species), with the introduction of national registers for such novelties; an international agreement on a uniform system of colors, and the necessity of affording legal protection for creators of floral varieties who, it is proposed, should be named for at least a period of three years whenever, in trade catalogues, mention is made of the novelty for which they are responsible.

THE first imperial agricultural research conference opened in London on October 1, with 170 representatives from all the Dominions of Great Britain, India and most of the colonies and dependencies. The conference is the outcome of last year's imperial conference and is primarily a business establishment and clearing house of information for coordination of the work of local research institutes.

AN International Congress of Hygiene will be held in Paris under the presidency of Professor Léon Bernard, from October 25 to 28. According to the *British Medical Journal* the following questions will be discussed: Relation of insurance to public health, introduced by Kuhn, of Copenhagen, Holtzmann, of Strasbourg, and Brian, of Paris; factors in the recrudescence of smallpox and the means of combating them, introduced by Ricardo Jorge, of Lisbon, Jitta, of the Hague, and Camus, of Paris; hygiene of education camps, introduced by Sacquépée, of Paris. Addresses will also be delivered by Professors Madsen and Ottolenghi.

THE Rockefeller school of biochemistry in the University of Oxford will be opened by the Right Hon. Viscount Cave, Lord Chancellor of England and Chancellor of the University, on October 21.

THE United States Civil Service Commission announces competitive examinations for chemical engineer at a salary of $3,800; associate chemical engineer at a salary of $3,000, and assistant chemical engineer at a salary of $2,400, applications for which must be received not later than November 8. The duties of appointees will be in connection with original research and development, or design and construction that is being conducted by the different bureaus in chemical engineering.

THE new sixteen-room psychological laboratory at Colgate University has been opened. The laboratory is divided into two parts, the first being a main laboratory of ten rooms for general applied and industrial experiments, and a special sleep laboratory of six rooms located away from the noise of the campus.

THE committee on scientific research of the American Medical Association has made a grant of two

hundred and fifty dollars to Dr. Warren C. Hunter, of the department of pathology, University of Oregon, for further study of the problem of local cellular immunity in renal epithelium.

DEAN C. F. BAKER, of the College of Agriculture at Los Banos, Philippine Islands, who died about three months ago, has left to the National Museum his collection of insects and some manuscripts, as well as a card index of Indo-Malayan entomology up to date, including about 100,000 references. The collection comprises more than 1,450 schmitt boxes of mounted specimens, as well as a large amount of unmounted material.

ON September 24 fire destroyed the old Oak Hill club house situated on the site of the new men's college of the University of Rochester. The building had been abandoned preparatory to demolition, but the basement was being used for the storage of geological exhibition cases and specimens from the old geological museum on Prince Street. Three exhibition cases that had been placed on the first floor of the club house were burned. Four more exhibition cases and two hundred boxes of geological specimens in the basement were not harmed by the fire. The lowest layer of boxes were half submerged in water, however, and their contents were necessarily dried and repacked. The water did not injure the specimens or obliterate the labels. The cost of repacking the specimens and the loss of the three exhibition cases were covered by insurance. The material menaced by the fire was no part of Ward's Natural Science Establishment, which institution has become incorporated into the University of Rochester.

WE learn from the *Journal* of the American Medical Association that Dr. John Whitridge Williams, professor of obstetrics, the Johns Hopkins University School of Medicine, Baltimore, has announced that a birth control clinic, supported by prominent physicians and others, will be opened this fall or winter on Broadway near the Johns Hopkins Hospital. It will differ from birth control clinics in most places in that propaganda will not be dispensed, and persons will not be accepted unless sent to the clinic by a physician. It will be purely an association of medical men and will be operated by them. Dr. Bessie L. Moses will be in charge. Dr. Moses is a graduate of the Johns Hopkins and an extern at the Johns Hopkins Hospital and was formerly connected with the Woman's Hospital in Philadelphia. Among those interested besides Dr. Williams are Dr. William H. Howell, director, the Johns Hopkins School of Hygiene and Public Health; Dr. Adolf Meyer, professor of psychiatry, and Dr. Raymond Pearl, director of the institute for biological research.

THE Soviet Academy of Sciences has reported that it has discovered the resting place of a large meteorite, estimated to weigh nearly half a million tons, which fell in a remote district of Yenesei Province, Siberia, in the summer of 1908. The site of the fall occupies over a mile in diameter in almost inaccessible terrain in a marshy forest. The meteorite fell in pieces, so that the ground is pitted with deep funnels from 50 to 100 feet in diameter. The forest for over fifteen miles around the place was completely leveled and the fallen tree trunks scorched. The fall, nineteen years ago, was registered on the seismographs at Irkutsk, 900 miles away, and in the towns of Kirensk and Ilimsk, about 250 miles distant.

UNIVERSITY AND EDUCATIONAL NOTES

MISS GWENTHALYN JONES, of Chicago, has made a gift of $200,000 for the endowment of a professorship in mathematical physics at Princeton University. The chair will be named after her uncle, Thomas D. Jones, of the Princeton class of 1876.

THE University of Chicago will receive $750,000 for the establishment of a free school of mechanic arts by the will of the late Edward T. Jeffery, banker and railroad executive.

VANDERBILT HALL, the new dormitory of the Harvard Medical School which has just been completed, will be dedicated on October 14, when George E. Vincent, president of the Rockefeller Foundation, will deliver the principal address.

DR. WM. RANDOLPH TAYLOR has been promoted to a full professorship of botany at the University of Pennsylvania. He recently returned from a fourth trip devoted to a study of Alpine lakes in the high mountains of British Columbia, completing a group of observations on Alpine algae peculiar to such situations, which have not previously been studied in America.

JOSEPH B. REYNOLDS, associate professor of mathematics and astronomy at Lehigh University, has been promoted to be professor of mathematics and theoretical mechanics. Dr. Reynolds spent the academic year just past, on leave, studying at Princeton University.

IN the department of physics at New York University the following promotions and additions have been made: Dr. H. H. Sheldon, from associate to professor of physics; Dr. W. A. Schneider, from instructor to assistant professor; Roger Estey, from graduate assistant to instructor; Edward O. Salant will work as a National Research Fellow in the department of

physics, Washington Square College; Dr. Francis A. Jenkins, formerly of Harvard University, has become an assistant professor of physics at University College on the Heights.

NEW appointments at Cornell University include those of Robert E. Loving, of the University of Richmond, acting professor of physics; W. W. Nicholas, formerly National Research Fellow, acting assistant professor in physics, and John R. Johnson, of the University of Illinois, assistant professor of organic chemistry.

AT the medical school of Western Reserve University, Dr. Howard H. Beard has been promoted to an assistant professorship of biochemistry and Edward Muntwyler has been appointed demonstrator of biochemistry.

DR. HARVEY A. ZINSZER, acting professor of physics at Mississippi State College for Women, has been elected professor of physics and acting professor of mathematics at Hanover College, Hanover, Indiana.

DR. CHARLES SPARLING EVANS, Ph.D., Princeton, has been appointed associate in geology at Bryn Mawr College.

M. A. STEWART, formerly instructor in biology at the University of Rochester, known to entomologists for his work on Siphonaptera, has been appointed instructor in biology at the Rice Institute.

DR. HOBART A. REIMANN, who recently finished his research work as a fellow in medicine of the National Research Council at the University of Prague, has been appointed assistant professor of medicine at Peking Union Medical College, Peking, China.

DISCUSSION AND CORRESPONDENCE

THE EFFECT OF X-RAY ON TRYOSINASE

THE organic pigment melanin is considered to be the result of the interaction of tyrosine and tyrosinase. When mushrooms or potatoes are ground up with water the water contains a considerable quantity of the enzyme. This can be demonstrated by adding a few drops of the water extract to a dilute solution of tyrosine. This colorless mixture during the first few hours passes through various deepening shades of wine to become black after twenty-four hours. When either potatoes or mushrooms are X-rayed before their extraction with water, this extract invariably shows a decided increase in its powers of melanin production. This increase is in direct proportion to the strength of the X-ray dose. As far as the work has been carried exposures of 30, 60, 90 and 120 minutes at 30 KV., 22 ma., 26 cm. target distance result in increasing depths of color when added to a tyrosine solution that form steps sufficiently sharp to be obvious even in a photograph. Exposures over 2 hours and up to 4 hours produced no further perceptible change. From the results obtained with mice it seems probable that a very severe exposure of this enzyme would cause either a decrease or even a complete inhibition of its activity.

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DEFINING SOIL COLLOIDS

ONE of the most popular and widely studied and discussed problems at the present time in the domain of soils is soil colloids. And yet there are probably no two people interested in the subject who agree completely as to a definition of soil colloids. The concepts and definitions of soil colloids seem to vary enormously. Some people call soil colloids only soil particles of the very smallest size which have an upper limit of not more than .000005 millimeter, while other people call colloids soil particles whose upper limit is .005 millimeter and even .008 millimeter. It behooves us, therefore, to have a correct and standard definition of soil colloids.

Now the vital question is, what standard are we going to adopt upon which to base a standard and correct definition of soil colloids?

There are two apparent standards that present themselves—one is the size of the particles and the other the activity or energy manifestations of the particles.

In choosing one of these two standards, it is absolutely necessary to choose one that has or presents a natural transition or demarcation point which divides the soil material quite distinctly into colloidal and non-colloidal.

The activity or energy manifestations of the soil particles seems to meet the essential requirement of possessing a natural transition point which will divide soil material into colloids and non-colloids. For instance, such energy manifestation or phenomena as adsorption of water vapor, base exchange, heat of wetting, etc., are possessed only by the soil colloidal material and not at all or very little by the non-soil colloidal material.

A thorough examination of all the energy phenomena manifested by the soil particles that of the heat of wetting in water appears to be the most logical to adopt as a standard criterion for defining colloids.

The liquid to use in the heat of wetting measurement and hence, in the definition of the soil colloids is water. By using water all objections that might

be raised as to the specificity of the heat of wetting between soil material and different liquids, are overcome, because water, besides being the most natural and universal reagent, it is the chief natural agent by which soil colloids have been formed. Water is mainly responsible for the formation and physical condition of the soil colloids.

If the heat of wetting phenomena is accepted as a criterion for distinguishing colloids from non-colloids then soil colloids could be defined as any soil material dried at 110° C. that will give heat of wetting in water irrespective of size of particles.

It has been found experimentally that nearly all the soil material classified as clay, and some of the very finest silt, give heat of wetting. This would include soil particles as large as .008 mm. and even larger in some soils. Above the very finest silt there is hardly any measurable heat of wetting. All the organic matter that gives heat of wetting would also be classed as colloids.

According to the above definition of soil colloids then, any soil particles which give heat of wetting, which may be .008 mm. or larger in size would be classified as colloids. Such a definition and classification would be strongly objected to by those who believe that only material of the finest size, such as .000005 mm., should be classed as colloids. But what will these people say when they realize that particles of .008 mm., or larger and having the same composition as those of .000005 mm., also exhibit energy phenomena the same as those of the smaller size, only of a slightly lower degree? Are we not justified then in classifying the larger particles under the same category as the finest? The present classification of soil colloids, which is based upon an arbitrary size of particles, is illogical. A true classification should have for its basis a natural transition point, such as is possessed in the heat of wetting phenomenon, which shows definitely that above a certain size of particles the phenomenon of heat of wetting is not at all manifested.

If the phenomenon of heat of wetting is adopted as a criterion for defining soil colloids, then we not only have what appears to be a logical and correct definition, but also, by the aid of such a definition, we can determine the colloidal content of soils, in less than 15 minutes as compared to more than 10 days by other definitions. This is accomplished by the rather remarkable relationship that has been discovered to exist between the percentage of colloids as determined by the heat of wetting method, and the percentage of material that stays in suspension in a liter of water at the end of fifteen minutes. The heat of wetting method used for determining the colloids is by means of the ratio:

$$\frac{\text{Heat of wetting of soils}}{\text{Heat of wetting of extracted colloids}} \times 100 = \text{per cent. colloids}$$

The extracted soil colloids are obtained by allowing the dispersed soil to stand 24 hours in a beaker 6 inches high and siphoning off the material that stayed in suspension. This method of extracting colloids seems to give the best representative sample of colloids in any soil.

It is firmly believed that the definition of soil colloids as proposed here is a natural and logical definition. It is simple, definite and comprehensive. It will have very few exceptions.

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SCIENTORS APPEAR IN THE SOUTHWEST

A NUMBER of years ago some prosperous real estate operators awakened to the fact that they were being hampered in their chosen field by a motley array of amateurs of a low order. Something needed to be done and that quickly if real estate were to continue as an active field in which men of culture and refinement could profitably perform. Accordingly a few of the more erudite among them formulated an imposing set of platitudinous rules which would not interfere with "business as usual," but which would permit disbarment of unwelcome competitors. These gentlemen also had the wisdom to coin a new word—"realtor"—with which to dignify their new profession. Both the code of ethics and the new name were approved enthusiastically and are still in use, to the great benefit of all members in good standing.

Having seen what wonders a code of ethics accomplished for the barratrous real estate agents of the southwest, the scientists in that region have taken heart, and with true western optimism have adopted unanimously a set of trade rules of their own that should go far toward making the profession respectable—at least in the eyes of the public.

Many of us here in the economical East had no idea that science was in such a bad way in the far West. Of course we had our suspicions, but that investigators were mulcting each other of ideas and jobs, when they were not doing dishonest work for miserably inadequate pay, had never occurred to us. But the rules speak for themselves and show only too clearly just how deplorable everything is. Those interested in scientific slumming will find the reforms duly and dully set forth in SCIENCE[1] all nicely numbered and ab'd for ready reference.

[1] "A Code of Ethics for Scientific Men." SCIENCE, Vol. LXVI, No. 1700, pp. 103–104, July 29, 1927.

When once these rules are put in force, we can rest assured that the southwestern scientist in good standing will be courageously doing fine work, regardless of all sorts of prejudices. He will not be maliciously criticizing his colleagues nor will he have stolen their mental offspring or their means of subsistence. In fact he will be wholly respectable, scientifically speaking. His pay will be adequate and he will enjoy administrative authority of a sort. His publications will be prompt but not too prompt and the public will be in his confidence, for he will have learned that the public pays the bills. He will be conversant with politics, religion and economics, but it will be useless to approach him on literature, history or philosophy, for these have been left to the charlatans as unworthy of ethical scientists.

With all this careful charting of the course of the true scientist the rules committee unfortunately neglected the all-important matter of a distinctive name and appropriate insignia for these new paragons of scientific virtue.

As any realtor could have told them, rules are all right as far as they go, but the important thing is for the paying public to be able to discriminate between those who have a framed copy of the rules and those who have not. The southwestern scientists, having aped the realtors to the extent of adopting a code of ethics, should go the rest of the way and grasp the substance of reform by choosing a name.

The writer, ever anxious to encourage and aid in the salvation of southwestern science suggests "Scientor"[2] as a designation for those very earnest-minded practitioners seeking a way out of the wilderness—or what have you?

J. H. KEMPTON

BUREAU OF PLANT INDUSTRY

A DAYLIGHT METEOR

I READ with great interest the note of William L. Bryant, entitled "A Daylight Meteor," which appeared in the issue of SCIENCE of July 22, 1927. Several years ago, about four o'clock in the afternoon of a beautiful October day, while walking in the open country just north of the city of Stamford, Conn., I chanced to see at an elevation of about 30° above the horizon a veritable "ball of fire" moving in a northerly direction with an exceedingly high velocity. The brilliance of the moving body, which I immediately assumed to be a daylight meteor, was fairly dazzling notwithstanding the fact that the sun was shining brightly in the western sky. During the brief interval that the meteor was visible its trajectory appeared to be nearly horizontal. Unlike the luminous body observed by Mr. Bryant, the daylight meteor which I chanced to see did not leave a train of sparks in its wake. Unfortunately, I was alone at the time when this phenomenon occurred and hence was unable to compare my observations with those of an independent observer.

FREDERICK H. GETMAN

[2] Lest I be accused of transgressing Rule 10 of the southwestern code I hasten to admit having read a series of letters, appearing in *Nature* a year or so ago, in which the question of a proper designation for men of science was discussed. Although I am not conscious that Scientor was among the suggested appellations, it may well have been, and ethically I can claim credit only for appreciating its appropriateness for the group of men in question.

QUOTATIONS

SCIENCE FOR CITIZENSHIP

OF the importance of science in any modern system of education there can here be no question: but there is danger of a certain confusion of thought. The value of the practical application of science was fully brought out during the war; it has been apparent in many of the problems which have arisen since the war; while scientific men have repeatedly and justifiably urged upon the public and the government the fundamental importance of the promotion of scientific research for all departments of the administration and life of the community and the British Empire. This insistence upon the value of science, aided by a confusion between instruction in science and a technical training, has obscured its true function as an element in the training of the average individual in preparation for his duties as a member of the community. Now that science enters so widely and so intimately into every department of life, especially in all questions relating to health and well-being, it is essential that both the individual who ultimately through the vote will control policy, as well as those by whom that policy will be framed and carried out, should have a general knowledge of the scope and aims of science, as well as of scientific method and the mode in which science envisages and attacks its problems. It is, however, beyond question that it should be a general knowledge on broad lines: a specialized training in some highly technical branch of science is neither needed, nor indeed is it desirable. The educationist need feel no alarm.

As a medium of culture, the history of scientific discovery opens up to the imagination vistas of man's endeavor which place it in the front rank of humanistic studies. Through a general familiarity with the

methods of scientific observation and experiment in the various branches of research may be developed a critical attitude in judgment, a power of observation and a capacity for orderly arrangement; while a knowledge of the questions with which science as a whole is concerned in the past, present and the future, fosters the broad outlook which, in combination with these qualities, is essential in successful dealing with the problems of life. We doubt, however, whether much of the science teaching in schools, either primary or secondary, could be regarded as science for citizenship instead of science for specialists, and we should welcome a movement which would broaden its scope and change its character.—*Nature.*

THE FALL LINE OF THE EASTERN UNITED STATES

THE fall line is one of the most significant physiographic features of the eastern United States, but its origin has long been a mooted question. The fall line is not particularly striking in its physical expression but its east-facing slope gives rise to a remarkable series of falls, rapids or deflections in the streams which flow from the Appalachian province across the Coastal Plain to the Atlantic Ocean.

The fall line, or fall zone as it may more appropriately be called, has been commonly recognized as extending for more than 800 miles, from central Georgia to somewhere in the neighborhood of New York harbor, and following the contact between the crystalline rocks of the Piedmont area and the soft sedimentary formations of the Coastal Plain. All the early geologists and physiographers assumed that the fall line was a natural outcome of streams crossing the line of contact between two areas, one of resistant rocks and the other of relatively non-resistant rocks. This apparently adequate explanation was long given credence and, indeed, to-day many still hold to it. But it must be rejected in the light of the fact that the upper portions of the streams on the Piedmont are as well graded as the lower portions on the Coastal Plain. For if the falls were due to difference in the rate of stream development on areas of unlike rock resistance, the upper courses of the rivers should manifestly be in physiographic youth while their lower courses should be physiographically more mature. This is, however, not the case.

It was soon recognized that the fall line was not explicable solely on the basis of difference in resistance to stream downcutting in two petrographic provinces, so in 1888, W. J. McGee set forth the hypothesis that the fall line was due to monoclinal flexing or faulting. This theory appears to have been accepted by N. H. Darton, N. M. Fenneman, Cleveland Abbe, Jr., Isaiah Bowman and many others. Joseph Barrell, however, clearly showed that while faulting does occur near the fall line in one or two places, there is no evidence of displacement throughout most of its length, particularly in places where some of the most pronounced stream declivities occur.

W. M. Davis in his "Physical Geography" (published in 1898) sets forth a very ingenious hypothesis, which if true is entirely adequate to explain the fall line. On page 127, of this book, Dr. Davis gives in essence the following explanation: Before the Piedmont and Coastal Plain were uplifted the rivers had cut valleys of gentle slope leading to what was then base-level—the shore-line along the outer (eastern) edge of the Piedmont. After emergence, the extended rivers rapidly entrenched their lower courses in the non-resistant sediments of the Coastal Plain, while downcutting proceeded very slowly in the hard rocks of the Piedmont. These new valleys of the lower courses of the streams, worked headward until they encountered the resistant rocks beneath the Coastal Plain sediments near its inner margin, where downcutting was checked. Thus the middle portion of the stream, between the gentle upper reaches on the Piedmont and the gently sloping lower entrenched portion in the Coastal Plain, possesses a relatively steeper slope and hence is marked by falls and rapids.

Davis's explanation is thus based on the assumption that the surface of the Piedmont is continued beneath the sedimentary formations of the Coastal Plain, and this embodies the necessary implication that the gradients of the Piedmont portions of the streams are less than the slope of the upland peneplane surface.

In order to analyze the problem quantitatively, the writer constructed many projected surface profiles across the Piedmont and Coastal Plain at right angles to the fall line, plotting on the profiles the outcrops of the various geological formations together with the depths of well borings in the Coastal Plain to determine the slope of the crystalline basement. Several different vertical exaggerations of scale were used in order that the various elements of the relief might be studied to best advantages.

The profiles show especially well the peneplain nature of the Piedmont upland and the New England upland. These uplands should probably be considered as two sections of the same peneplain (probably Tertiary in age). The slope of this Piedmont-New England peneplain surface varies from 5 feet per mile in Georgia to 18 feet per mile in Maine. The slope of the crystalline basement below the Coastal Plain varies from 36 feet per mile to 85 feet per mile, showing clearly that the Piedmont-New England up-

nd surface is not continued beneath the Cretaceous rmation of the Coastal Plain. The much greater ope of the crystalline basement below the Coastal lain makes the marked angle formed by the inter- ction of these two surfaces recognizable even when small vertical exaggeration is used.

When records of scattered well drillings along a ne in the Coastal Plain are plotted, they seem to dicate that the crystalline basement closely approxi- ates a plane surface. Very probably the surface the crystalline basement is a buried peneplane veloped during pre-Cretacic (Jurassic?) times. he slope of this buried and tilted Jurassic pene- lane emerges from beneath the Coastal Plain sedi- ents, and continues upward along the face of the ll line belt of the Piedmont, being revealed through e stripping away of the Coastal Plain sediments erosion. The width of this stripped zone is slight, rying from 2 to 4 miles along the Piedmont. In ew England, however, the Coastal Plain is entirely moved (except that portion which is below sea- vel), leaving a stripped zone varying from 5 to 15 iles in width. The exposed edge of this old Jurassic eneplain is continued across the bottom of the Gulf Maine with a width of about 15 miles.

Several writers have long known that the slope of e Piedmont is not continued beneath the Coastal lain and that there are two upland slopes in New ngland; indeed, Davis himself has recognized this nd commented on it. But what is vastly more sig- ificant, it has not been recognized that since this is ue no falls could result from the conditions em- odied in Davis's theory. If, as Davis suggested, the iedmont rivers had established very gentle gradients ading to an ancient shore-line near the present fall line," the upland profile and the stream profile ust have been intersected at that point. After the nergence of the Coastal Plain, the extended rivers ust have entrenched themselves in the soft Coastal lain sediments until they had established nearly level hannels in their lower courses, whereas downcutting roceeded very slowly in the crystalline rocks of the iedmont. This would have resulted in a broken tream profile in which the stream in the outer (east- rn) Piedmont would have been entrenched but little elow the upland surface, while in the western Pied- ont and the Coastal Plain it would have been greatly ntrenched.

But actual profiles show that the streams are en- renched as far below the upland surface in the east- rn Piedmont as in the western Piedmont. If this act is applied to a diagram showing the Piedmont urface as being continued beneath the Coastal Plain gives only a simple concave stream profile which could yield no falls and rapids whatsoever. Thus the postulate of an ancient shore-line at the fall line is untenable, and the break in stream gradient is only incidentally related to differential entrenchment in areas of unequal rock resistance.

On the other hand, the profiles show that there is a marked break in the slope of the Piedmont-New England upland, and it is at this point that the streams which are *uniformly* entrenched below the upland surface exhibit the break in their gradients.

The fall line zone, therefore, lies along the outer edge of the crystalline area (the Piedmont-New England Upland Province), where there is a break in the slope of the land due to the intersection of the recently exposed margin of the old, tilted Jurassic peneplain and the newer Tertiary peneplain of the uplands. Since the gradients of the streams are closely related to the profile of the land, this break is sufficient to account for falls and rapids.

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SCIENTIFIC APPARATUS AND LABORATORY METHODS

PRECIPITATION OF THE VIRUS OF TOBACCO MOSAIC

IN an attempt to free the virus of tobacco mosaic from as much contaminating material as possible a method has been devised whereby the freshly cut diseased tobacco tissues are frozen, allowed to thaw, and then subjected to high pressure. The juice obtained, after being centrifuged, at about 2000 r.p.m., contains no large particles in suspension, but is highly infectious.

When two volumes of acetone (c. p.) at $-8°$ C. are added to one volume of the juice held at about 0° C. a flocculent precipitate is thrown out and rapidly settles. The supernatant liquid can be almost completely decanted within two minutes after adding the acetone, leaving the precipitate in the bottom of the container. More water may then be removed by rinsing the precipitate with acetone (c. p.) at $-8°$ C., decanting the acetone and then removing the remaining acetone with absolute ether at $-8°$ C. by rinsing twice and thoroughly draining off the ether. The precipitate thus obtained is readily soluble in distilled water. Experiments in which young tobacco plants were inoculated with this solution showed it to be highly infectious. The first supernatant liquid decanted, on the other hand, when centrifuged to free it from all traces of the precipitate and diluted with two parts of distilled water proved to be non-infectious. The dilution was made in order to bring the

concentration of acetone below the point which Allard[1] showed was non-toxic to the virus.

Absolute alcohol may be used in place of acetone under the above-mentioned conditions.

At about 100 per cent. saturation and −8° C. ammonium sulfate salts out from the juice, material which, when filtered off and sucked dry, dissolves readily in distilled water. Plants when inoculated with this solution take the disease. The filtrate when diluted, one to five, has in no case transmitted the disease; although the untreated juice when containing ammonium sulfate solution at a concentration of 3 cc. of a saturated solution to 10 cc. of the juice is infectious.

Solutions of Safranin-O have also been used to precipitate the virus from the plant juice. This gives a quantitative precipitation, which frees the juice of virus.

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BROWNIAN MOVEMENTS WITH LOW MAGNIFICATION

THE desire having arisen for conspicuous Brownian movements, a variety of materials was pulverized with a view to ascertaining which showed the movements to best advantage. For several reasons mica, particularly in the form of muscovite, was found preferable.

The suspension to be observed may be prepared as follows. A quantity of mica from the edge of a natural slab is ground by a dry emery wheel into an impalpable dust. This is stirred into a graduate of water and allowed to stand for some four hours. After the larger flakes have settled to the bottom, the thin milky suspension is siphoned off, care being taken not to draw off any of the useless residue at the same time. The concentration of the liquid may, of course, be altered as seems convenient by evaporation or dilution.

The liquid so prepared contains particles most of which are so small as to exhibit the Brownian movements. Under a magnification of fifty diameters with oblique illumination from below the microscope stage, the flakes appear as bright scintillating points in a dark field. This scintillation is evidently caused by small angular displacements due to the atomic bombardment; as the flakes rotate, they reflect the light at irregular intervals. Mica is peculiarly well adapted to this method of observation because each thin particle has a moment of inertia small in comparison with its reflecting area.

In such a field, the movements are still conspicuous with a magnification of ten diameters, and have been suspected with the naked eye.

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[1] Allard, H. A. *Jour. Agr. Res.* 13: p. 619 (1918).

SPECIAL ARTICLES

HYSTERESIS LOSS IN NICKEL OF DIFFERENT GRAIN-SIZE

THE hysteresis loss in specimens of nickel crystals which varied from one grain per specimen to as high as 2.8×10^6, has been examined by Sucksmith and Potter[1] and found to increase rapidly as the number of crystal grains increased. Such an effect is not limited to specimens specially prepared as crystals but may be found as well in strips of ordinary nickel which have been successively cold rolled to thinner and thinner specimens and thus the number of crystals per unit volume increased step by step as well as the hardness.

Of course all metals are crystalline, but in the case of the nickel strips which are cold rolled, it is not until severe cold working is performed that the crystals are more or less aligned[2] in one direction.

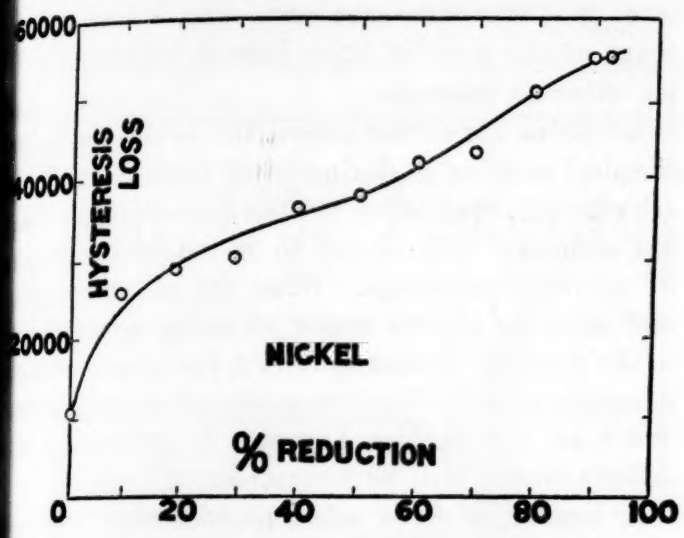
The present writer had occasion recently to study some of the magnetic properties of a series of eleven nickel strips reduced to various thicknesses by successive cold rolling. These strips were 57.7 cm. long and about 0.954 cm. wide. The thickest strip was .604 cm. in thickness and the ten succeeding strips were rolled from this thickness to those given by the percentage cold reduction in the following table:

No. of Strip	Per cent. cold reduction from mill records	Hysteresis loss Ergs/cm³/cycle	Thickness	Chemical Analysis
1	0.0	10861	0.604	Nickel 98.88
2	9.7	26146	0.550	Iron 0.56
3	18.9	29165	0.496	Manganese 0.23
4	28.6	30538	0.435	Copper 0.16
5	39.5	37526	0.372	Carbon 0.09
6	50.0	38732	0.306	Silicon 0.06
7	59.5	42373	0.249	Sulphur 0.00
8	69.0	43924	0.194	
9	79.0	51086	0.133	
10	89.1	55144	0.070	
11	93.3	55042	0.044	

[1] Sucksmith and Potter, *Nature*, 118, p. 730, Nov. 2[illegible] 1926.

[2] Jeffries, *Trans. Amer. Inst. Min. & Met. Eng.*, 7[illegible] p. 303, 1924.

The photomicrographs[3] of these strips show a much ner grain structure for the specimens having the reater reduction in thickness and thus we assume at the per cent. of cold reduction is some measure f the number of crystal grains per unit volume even ough with random orientation. We may, therefore, lot the relation between per cent. of cold reduction



d hysteresis loss. This is shown in Fig. 1 and conrms the relation found by others that large grain ze is conducive to small hysteresis loss. Honda and aya[4] in a recent study of the magnetic properties single crystals of iron find a similar law holding their work. The same conclusion may be drawn om Gerlach's[5] curves for the magnetization of ngle iron crystals and electrolytic specimens. orensen[6] ascribed the high coercive force in thin ms of iron, cobalt and nickel as due to the minute ze of the crystals. Edwards[7] had a similar experice. The recent work of Ishagaki[8] on the effect of ain-size on the hardness of pure iron fits into the me picture.

It is interesting to note, on the other hand, that elo and Baudisch[9] found for precipitated magnetite at "lean hysteresis loops, low coercitivities and low manences are associated with oxides composed of all crystals."

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[3] Williams, *Proc. A. S. S. T.*, 1926.
[4] Honda and Kaya, *Sci. Reps.* Tohoku Imp. Univ., 15, 729, Nov., 1926.
[5] Gerlach, *Ztschr. f. Phys.*, 38, p. 832, 1926.
[6] Sorensen, Amer. Phys. Soc. Program, Abstract, Nov. 29, 1924, *Phys. Rev.*, 24, p. 658, 1924.
[7] Edwards, Amer. Phys. Soc. Program Abstract, Dec. 30, 1925.
[8] Ishagaki, *Sci. Reps.*, Tohoku Imp. Univ., 16, p. 285, 27.
[9] Welo and Baudisch, Amer. Phys. Program, Abstract, eb. 26–27, 1926.

A DYSENTERY-LIKE BACILLUS FROM A PHLEGMONOUS INFLAMMATION

THE bacilli belonging to the dysentery group have with few exceptions been isolated from the intestinal and urinary tracts. The writer has found but one reference to the isolation of one of this group from an extremity. Magnusson, 1919,[1] isolated a dysentery bacillus, which he named *Bacterium viscosum equi,* from "joint ill" in foals. Since the bacillus to be described was isolated from a phlegmonous inflammation of the lower leg and foot of a man, it will, perhaps, be of interest.

The isolated bacillus has the following characteristics:

Non-motile, Gram-negative, non-spore-forming, short rods.
Aerobic and facultative anaerobic.
Gelatin colonies: grayish-white, raised, entire.
Gelatin stab: no liquefaction.
Agar colonies: gray, smooth, entire.
Agar slant: gray, smooth, glistening.
Broth: turbid.
Milk: acid. Slow coagulation.
Indol is formed.
Acetyl-methyl-carbinol not formed.
Nitrates not reduced.
H_2S not formed.
Acid, but not gas, in lactose, saccharose, mannite, dextrose, maltose, raffinose, arabinose, adonite, sorbite, galactose, levulose, salicin, glycerin, xylose and trehalose.
No acid or gas in dulcite, dextrin, inulin, inosite, amygdalin or rhamnose.

Andrewes, 1918,[2] proposed the name *Bacillus dispar* for all lactose-fermenting members of the dysentery group, but *Bacillus madampensis* Castellani, 1912, and *Bacillus ceylonensis* Castellani, 1909, were evidently included in the group as shown by the reaction of the strains of *B. dispar* to dulcite.

The bacillus herein described differs from *B. madampensis* in that it ferments adonite and salicin, and does not ferment dextrin nor rhamnose. The nonfermentation of dulcite differentiates the bacillus from *B. ceylonensis.*

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THE SELECTIVE EFFECT OF POLARIZED RADIATIONS ON CERTAIN PHOTOCHEMICAL REACTIONS

THE selective effects of polarized light as compared with ordinary light on biochemical reactions

[1] *Jour. Comp. Path. and Therap.*, 32, 143.
[2] *Lancet*, 1918, 1, 560.

were first brought into prominence by Elizabeth Sidney Semmens (*Journ. Soc. Chem. Ind.,* 42, 954, 1923, also Brit. Assoc. Report, 1923).

In two previous notes by Bhatnagar and Lall and Bhatnagar, Lall and Mathur (*Nature;* February 27, 1926, and July 3, 1926) the effect of polarized light with the electric vector in the light-wave vibrating in the plane of incidence was shown to be selective on animal metabolism and on growth of *V. cholerae* and *B. typhosis.* Further work on the subject has been published from this laboratory in the *Indian Journal of Medical Research* (Vol. XIV, No. 2, October, 1926).

No positive results seem to have been so far recorded in favor of a selective effect on purely photochemical reaction, though there are some unsuccessful attempts described in literature (Ghosh, *Journ. Ind. Chem. Soc.,* 1925, Vol. 2, p. 269). Investigations were therefore undertaken to find whether polarized light would accelerate purely chemical reactions as it does some of the biochemical reactions studied by Baly and Semmens, Hill and Macht and Bhatnagar, Lall and Mathur. Positive results have now been obtained in the case of the interactions of liquid amalgam of sodium or potassium and water. This reaction was shown to be photo-sensitive by Bhatnagar, Mata Prasad and D. M. Mukherjee (*Journ. Ind. Chem. Soc.,* 1925, Vol. 1, 263).

The apparatus employed to obtain two fairly large patches of the polarized light and ordinary light of the same intensity was the same as described in a previous note (*Nature,* July 3, 1926). Spectra of the two beams of light taken in the visible region by means of an Adam Hilgers Spectrograph were found to be identical. The heat-rays were cut off from the reaction vessels by interposing in each arm of the apparatus a rectangular glass cell containing a strong solution of alum. The equality of intensities was measured by means of a Hilger Thermopile and Broca Galvanometer as described in the note referred to above. The polarized beam indicated a polarization of 90.5 per cent. as measured by means of a Savart's polariscope.

The reaction between the amalgams of the alkali-metals and water takes place in the dark, but is considerably accelerated by light even in the visible region. As a result of this reaction hydrogen and sodium hydroxide are produced.

The rate of the reaction was studied in two ways: (1) By measuring in a capillary tube the movements of a column of mercury due to the generation of hydrogen, (2) by titrating the alkali produced against a standard solution of an acid.

Both sets of experiments showed a remarkable acceleration of reaction when the reaction vessels were exposed to polarized radiations with the electric vector vibrating parallel to the plane of incidence. These results have been verified in hundreds of experiments. The differences in accelerations produced are not small and with suitable surfaces of the alloys exposed to the two kinds of radiations, they are as large as thirty-three per cent., and a complete account of the work is being communicated to one of the chemical journals.

As far as the author knows, this is the first purely chemical reaction as distinguished from the biochemical reactions studied by previous investigators which has definitely been shown to be selectively affected by polarized radiations. When the radiations polarized with the electric vector vibrating perpendicular to the plane of incidence, fall on the reaction vessels, minimum accelerations are produced in the reaction. Work on this subject, however, is in progress and definite results will be communicated later on.

A large number of other photochemical reactions such as the photo-decomposition of hydrogen peroxide, the reaction between mercuric chloride and ammonium oxalate in presence of iron chloride have been tried with negative results. From a large number of the photochemical reactions studied from this standpoint, it appears so far that the photochemical reaction in heterogeneous system only show this selective action and that the surface plays some part in this reaction.

In this connection it is interesting to recall the remarkable discovery which Elster and Geitel made in 1894 that in certain cases the photoelectric effect is influenced by the orientation of the plane of polarization of the incident light. Using also the liquid alloy of sodium and potassium and allowing polarized white light to fall upon surface, at an angle of 45°, they found a maximum current when the electric vector in the light wave was vibrating in the plane of incidence and a minimum current when the electric vector was perpendicular to the plane of incidence. These experiments have been confirmed by Kunz and a number of other workers and have received a satisfactory explanation through the work of Pohl and Pringshein (*Deutsch. Phys. Gesell,* Veb., 12, p. 215-228, 349, 360, 1910).

It is proposed to apply and extend the view of Pohl and Pringsheim regarding this selective effect of polarized radiations to the case of photo-chemical reactions described in this note.

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